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A

TREATISE

ON THE

DISEASES OF ARTERIES AND VEINS.

PHYSICAL SOCIETY
Instituted
1771.
GUY'S HOSPITAL

A

TREATISE

ON THE

DISEASES OF ARTERIES AND VEINS,

CONTAINING

THE PATHOLOGY AND TREATMENT

OF

ANEURISMS

AND

WOUNDED ARTERIES.

By JOSEPH HODGSON,

MEMBER OF THE ROYAL COLLEGE OF SURGEONS IN LONDON.

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KING'S COLLEGE LONDON

TO THE

MASTER, GOVERNORS,

AND

COURT OF ASSISTANTS,

OF THE

ROYAL COLLEGE OF SURGEONS

IN LONDON,

THIS TREATISE

IS INSCRIBED BY THE AUTHOR,

AS A GRATEFUL ACKNOWLEDGMENT OF THEIR

APPROBATION OF

THE ESSAY

ON WHICH IT IS FOUNDED.

PREFACE.

THE Diseases of Arteries had for some time engaged my attention, when the Royal College of Surgeons in London proposed, as the subject of the Jacksonian Prize for the year 1811, "Wounds and Diseases of Arteries and Veins." I was happy in the opportunity of submitting the observations which I had collected to the consideration of the Committee, and had the gratification of receiving a testimony of their favourable judgment, in the adjudication of the Prize to my Essay. In the course of the same year I was able to lay before the College a collection of cases, illustrating some parts of the subjects which had been imperfectly considered in my Dissertation; and the papers, on these two

occasions presented to the College, have furnished the chief materials of the following Treatise.

My principal objects have been to examine the various morbid appearances that are met with in the coats of arteries; to trace the pathology of aneurism; to investigate the processes by which the spontaneous cure of this disease is sometimes accomplished; to compare these processes with the effects of medical and surgical treatment; and, from the result of these inquiries, to deduce the principles which regulate the treatment of this disease. I have also been desirous of collecting and arranging observations relating to the improvements which have recently been made in the different operations for aneurism, so as to form an historical, as well as practical account of these important subjects.

I endeavoured to represent the diseases of arteries by a series of drawings, which were presented to the College. Engravings have been made from some of these drawings, which illustrate particular parts of this Treatise, or represent appearances that have not hitherto been delineated. Although referred to in this volume, they will be published separately, and will be accompanied with explanations, so that each part of the work may be, as much as possible, independent of the other.

My grateful acknowledgments are due to many friends, and more particularly to Dr. Farre, Mr. Abernethy, Mr. Astley Cooper, Mr. George Young, and Mr. Travers, for the opportunities which they have afforded me of investigating the subjects of this Treatise. Many of the cases which I have related occurred in the practice of

Mr. Freer of Birmingham, and I have sincere gratification in acknowledging the liberality which I have experienced from his friendship on this and many other occasions.

King Street, Cheapside,
Dec. 30th, 1814.

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A

TREATISE, &c.

PART I.

ON THE

DISEASES OF ARTERIES IN GENERAL.

The changes which arteries undergo in consequence of accident or disease, are referrible to the peculiar textures which enter into their composition. Arteries, like most other parts of the animal body, are composed of blood vessels, nerves, and absorbents, which render them liable to the same morbid alterations, and endow them with the same powers of reparation, as soft parts in general. Thus, the coats of arteries inflame and pass through all the stages of adhesion, suppuration, or gangrene, in the same manner as the skin, a gland, or a muscle. But these elementary textures are in arteries so

modified or arranged, as to form structures possessing peculiar properties, essential to the functions of the vessel. From this circumstance, arteries are liable to particular diseases arising from the peculiarities of their formation and functions. Thus, certain depositions and alterations take place in their coats, which we do not meet with in other structures; and their cavities undergo changes, which depend upon the actions of the vessels, and their subserviency to other organs.

With this view of the subject, I shall first consider those morbid changes which arteries undergo in common with soft parts in general; namely, inflammation and its consequences — the effusion of lymph and adhesion, suppuration, ulceration, and gangrene; and, secondly, those changes which arise from peculiarities in the structure of arteries, as calcareous depositions, and various morbid alterations in their coats, and preternatural dilatation of their cavities; and I shall then consider the subject of aneurism, as arising from one or other of these previous changes, or from accidental violence.

SECTION I.

OF INFLAMMATION OF THE COATS OF ARTERIES.

ALTHOUGH the internal coat of an artery differs essentially from every other membrane in the body, in its extreme tenuity and elasticity, the facility with which it is ruptured, and the peculiar unctuous appearance of its internal surface, still in one circumstance it bears a striking analogy to serous membranes, namely, in its tendency to assume the adhesive inflammation. This property is in blood vessels, as in all organs, the first agent of reparation in injuries from accident or disease, and is surprisingly manifested in the processes which effect the cure of a wounded or divided artery. The inflammation which is excited by the injury, produces an effusion of lymph which seals the extremity of the divided vessel, and extending to its internal coat, becomes the basis of adhesion and final obliteration. Punctured arteries also are united by the same adhesive process that repairs wounds in general. If irritation be excited in the coats of an artery by pressure, the adhesive inflammation is the consequence; an effusion of lymph takes place into the cellular membrane that connects the coats of the vessel, and into its cavity;

its sides coalesce, and it is rendered impervious. This effect of pressure upon an artery is illustrated by the obliteration of blood vessels compressed by large tumours, and by that cure which aneurisms occasionally undergo from the pressure of the sac upon the superior or inferior portion of the artery. The same adhesive process frequently prevents hæmorrhage where abscesses or extensive ulcerations exist in the neighbourhood of large blood vessels; for the inflammation which precedes the suppuration has in such cases produced an effusion of lymph between the coats and into the cavity of the artery, whereby it is obliterated. Thus, in cases of vomica where the substance of the lungs is much consumed, hæmorrhage is prevented by the closure of the branches of the pulmonary and bronchial arteries by the adhesive inflammation.

The most perfect demonstration however of the effect of acute inflammation upon the internal coat of an artery, is probably to be met with in those cases where the disease appears to have extended to the vessel from contiguous parts. The following case of extensive inflammation of the thoracic viscera, in which the disease existed also in the internal coat of the aorta, and had produced an effusion of lymph into the cavity of that vessel, was communicated to me by my friend, Dr. Farre.

CASE I.

A MAN who had recently returned from Jamaica, where he had been severely afflicted with dysentery, was attacked with violent pneumonia, which destroyed him in the course of five days. The cavities of the pleura were found to contain much lymph and serum. The pericardium was covered with lymph. The cells of the lungs were filled with bloody serum, and the bronchia were highly inflamed. All the thoracic viscera exhibited the effects of the highest degree of acute inflammation, which had extended also to the aorta, the internal coat of which was of a deep red colour, and a considerable effusion of lymph had taken place into its cavity. The effused lymph was very intimately connected with the internal coat of the vessel, and a plug of it had extended into the left subclavian artery, and nearly obliterated the cavity of that vessel*.

This case exhibits the effects of acute inflammation upon the internal coat of an artery, and shows the tendency which that membrane possesses to assume the adhesive inflammation. A similar state of the great blood vessels is occasionally met with in violent inflammations of the thoracic viscera. I have seen it in three cases of carditis, pneumonia,

* Plate 1, fig. 5.

and bronchitis, but in none had the effusion proceeded to so great an extent as in the instance above related. In one case the aorta was throughout of a deep scarlet colour; the posterior mediastinum was gorged with serum, and a little above the semilunar valves, the cellular membrane that connects the coats of the aorta was distended with lymph. This condition of the great arteries has been but little attended to by pathological writers. Morgagni and Boerhaave indeed mention its existence, and impute to it some of the symptoms of suffocation and oppression of the heart, that have been noticed in many thoracic diseases*. Portal also remarked it in a young man who died a few days after the repulsion of an acute eruption. The thoracic aorta was very red, swollen, and tender, and its internal coat near the diaphragm was particularly puffed and softened†. A similar effusion of lymph sometimes takes place in the neighbourhood of ulcerations and calcareous depositions in arteries. I have seen an ulcerated and thickened artery, where a plug of lymph, evidently effused by inflammation, filled the cavity of the common iliac.

Lymph which is thus effused into arteries sometimes becomes the matrix of vessels, and granulations or fungous growths are occasionally the conse-

* MORGAGNI, letter xxvi. art. 36.

† *Cours d'Anatomie Medicale*, tom. iii. p. 127.

quences. Granulations are not unfrequently met with at the origin of the aorta, particularly upon the semilunar valves, and also in the cavities of the heart, the lining membrane of which is continuous with that of the arteries, and appears to possess the same properties.

The inflammation which is excited in an artery by the application of a ligature, is sometimes propagated to a considerable extent along the vessel. I have seen the inflammation of the internal coat extend even to the heart after the ligature of the femoral artery in amputation, and I have known a similar effect produced by the application of a ligature for the cure of an aneurism in the upper extremity. Mr. Cline* and Mr. Abernethy† have also observed this circumstance after the ligature of the femoral artery for the cure of aneurisms; and it has been remarked in the hypogastric arteries, after the ligature of the umbilical cord‡.

The internal surface of arteries often exhibits a red appearance which does not arise from acute inflammation. The internal coat is of a deep scarlet colour, sometimes throughout the whole extent of the system; and on other occasions

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 171.

† *Surgical Observations*, part iv. p. 232. First Edition.

‡ Oehme, *Diss. de Morbis recens natorum Infantum Chirurgicis.* Lips. 1773.

this appearance is to be observed only in circumscribed patches. It is attended with no deposition of lymph, or thickening of the vessel; and if the internal coat be removed, the middle generally presents its natural appearance; whereas in the cases of acute inflammation which I have examined, the middle coat has always exhibited a preternatural degree of vascularity. This red appearance of the internal surface of an artery is often observed in the vicinity of coagula, and in those instances may probably be the effect of transudation after death. But I have very frequently remarked it where no coagulum has been found in the vessel, and it is generally to be observed in arteries that have been long exposed to the air in the dissecting room. I have however seen it in subjects that have been inspected a very few hours after death, and cannot therefore regard it as produced merely by exposure to the air. Whether it is to be considered as a change which takes place after death, or as a morbid appearance, I am unable to determine. Corvisart says that it has been regarded as the cause of a peculiar fever, and that Dr. Frank had observed it in nineteen instances of that disease*.

Arteries are also subject to chronic inflammation, which lays the foundation of various morbid

* Corvisart, *Essai sur les Maladies du Cœur*, p. 350.

alterations in their coats. Chronic inflammation is generally to be observed in thickened and calcareous arteries, particularly in aneurismal subjects. In some instances it may probably be regarded as the effect of those diseases, although it is more probable that such depositions or alterations of structure are caused by increased vascular action. The internal coat of the vessel is soft, thickened, and of a deep red colour, which is not uniform, but irregularly disposed in the vicinity of ulcerations, thickenings, or calcareous depositions*. This appearance in arteries has long been known, and accurately described by various authors, and the ancient physicians ascribed it to the effects of the morbid, acrimonious, syphilitic, and scorbutic humours that pervaded the system. Some modern writers also, and among others Scarpa†, Corvisart‡, and Richerand‖, are inclined to impute it to similar causes, and particularly to the action of the syphilitic virus, or of the mercury that is used for the cure of that disease. From my own observation I may remark, that I have for the most part found aneurism, and those organic alterations which generally attend the formation of aneurism, in subjects that have suffered much from venereal diseases,

* Plate I. fig. 4.

† SCARPA *on Aneurism*, WISHART'S *Translation*, p. 88.

‡ CORVISART, *Essai sur les Maladies du Cœur*, p. 319.

‖ RICHERAND, *Nosographie Chirurgicale*, tom. iv. p. 74.

and who have taken large quantities of mercury. It appears indeed by no means improbable, that the internal coat of arteries may be one of those parts over which some specific diseases may exert their peculiar influence. Our knowledge on this subject is at least not sufficiently extensive to warrant the total rejection of opinions which derive some authority from observation, although our information is too hypothetical to be regarded as placing the subject in the condition of an established fact. It is therefore mentioned at present only as an object worthy of attention.

SECTION II.

OF ULCERATION OF THE COATS OF ARTERIES.

Ulceration rarely takes place in an artery the coats of which have not undergone some previous morbid alteration. It is not unfrequently met with around the circumference of calcareous, and in the centre of atheromatous depositions*. The coats of an artery are occasionally so completely destroyed by such ulcerations, that the blood passes into the cellular membrane surrounding the vessel, which is expanded into a sac, and this is one of the modes in which aneurism is produced. Sometimes matter may be pressed from underneath

* Plate 1. fig. 1.

the edges of such ulcerations, and I have seen a large ulcer situated immediately underneath the semilunar valves of the aorta, which contained a considerable quantity of pus*. Pus however is rarely seen about these ulcers, because it is no sooner secreted than it is washed away by the stream of blood passing through the vessel. It is not improbable that the internal coat of arteries, during inflammation, may secrete pus without the existence of ulceration, as sometimes it happens in serous membranes. The current however through the vessel would prevent such a state being distinguishable.

Many passive hæmorrhages, as apoplexy, hæmatemesis, hæmopthysis, &c. have their origin in this state of the arteries. Ulceration also frequently extends from surrounding parts, and the inflammation not being of the adhesive kind, and consequently having no power to obstruct the canal of the artery, its cavity is exposed, and hæmorrhage is the consequence. This frequently happens in cancerous and phagedenic ulcers, and I have met with it in a case of extensive ulceration of the stomach, which penetrated the coronary artery, and gave rise to a fatal hæmatemesis. In another case, in which a schirrous tumour was attached to the posterior surface of the stomach, and involved the splenic artery, the ulceration ex-

* Plate I. fig. 7.

tended to the latter, and gave rise to a similar result. Pulmonary hæmorrhage has frequently its origin in the exposure of the vessels of the lungs by vomicæ, as was the case in the following instance.

CASE II.

A MAN of a phthisical habit had for some time complained of cough and difficulty of breathing. In this state he was suddenly seized with pain in the left side, which rendered his breathing very laborious. He was unable to lie on his right side, his countenance was pale and deathlike, and his pulse weak and quick. He continued in this state two days, at the end of which he died. The left side of the thorax was found to contain about a quart of coagulated blood. The lungs contained numerous vomicæ, into one of which a considerable branch of the pulmonary artery opened. This vomica had burst into the cavity of the thorax, and from this source had proceeded the hæmorrhage. The aorta was thickened, and covered with calcareous depositions.

SECTION III.

OF SPHACELATION OF THE COATS OF ARTERIES.

INFLAMMATION, when confined to the internal coat of arteries, very rarely terminates in sphacela-

tion, at least I have not been able to meet with the circumstance upon record, nor have my own observations afforded any instances of it. Arteries, however, are frequently involved in the sloughing of surrounding parts, in which case the blood generally coagulates in the vessel to a considerable extent above the line of sphacelation. This circumstance prevents the accession of hæmorrhage upon the separation of the slough; and the coagulum being subsequently absorbed, the vessel contracts, and is ultimately obliterated. The cause of the formation of this coagulum is by no means evident, although it is probable that the condition of the mortified vessel interrupts the passage of the blood through it, and a coagulum is consequently formed extending to the next important collateral branch. Amputation is sometimes performed a little above the line of separation in which it is unnecessary to tie the arteries, and parts destroyed by sphacelation generally separate without the occurrence of hæmorrhage, the cavities of the vessels being plugged with coagulum.

SECTION IV.

OF VARIOUS MORBID APPEARANCES IN THE COATS OF ARTERIES.

I. The internal coat of arteries is sometimes thickened and converted into a substance resem-

bling cartilage, or the thickened peritoneum of an old herniary sac. If the coats of the vessel be separated, the disease will be found to occupy only the internal coat, which, having lost its elasticity, sometimes cracks, and forms scales that hang into the cavity of the vessel. This alteration of structure generally takes place to a considerable extent, and is frequently accompanied with a deposition of calcareous matter. The surrounding parts of the membrane generally exhibit the appearances of chronic inflammation, but I have never seen red vessels on that portion of the internal coat which had been converted into this cartilaginous structure. It is by no means so frequently met with as many other diseases of the coats of arteries.

The semilunar valves of the aorta are not unfrequently changed into a dense fibrous structure, somewhat similar to that of ligaments or tendons. Sometimes they are converted into cartilage, and appear to have undergone that alteration which I have just described as being occasionally met with in other parts of the system. They have a coarse, shrivelled, and contracted appearance when thus diseased, and are manifestly incompetent to their office as valves*. In several specimens, I have observed them to be ruptured, and form cartilaginous eminences on the sides of the vessel. These

* Plate 1. fig. 6.

ligamentous or cartilaginous conditions of the valves, are frequently accompanied with that increase of the muscular structure of the left ventricle, which has been termed active aneurism of the heart. I have seldom seen the latter disease without some morbid alteration of the semilunar valves, and generally their condition has been such as rendered them incompetent to support the stream of blood that was thrown into the aorta. Their rigid and contracted state, when converted into cartilage, renders them unable to close the area of the vessel, and of course some portion of the blood that is thrown into the aorta regurgitates into the ventricle. The latter is thus kept in a state of constant irritation, which may probably excite that increased growth of its muscular parietes which constitutes active aneurism.

II. The internal surface of arteries very frequently exhibits a thickened and pulpy structure, which, like the former, is confined also to the internal coat*. Sometimes the appearance is that of small flattened tubercles, and at others the whole surface is irregular, and somewhat fleshy; which latter circumstance, I imagine, has led Scarpa to denominate this the steatomatous condition of an artery. It is very frequently met with in aneurismal subjects. The elasticity of the internal coat being destroyed

* Plate 1. fig. 3.

by this alteration of its structure, it is lacerated by the impulse of the circulation, and thus gives rise to the formation of aneurism. I have never met with ulceration of that portion of an artery which presented this diseased appearance.

III. One of the most frequent appearances of disease in the coats of arteries, is produced by a deposition of atheromatous*, or purulent matter, in the cellular membrane, that connects the internal and middle coats of the vessel. The diseased part is of an opaque yellow colour, and is generally somewhat elevated from the surrounding surface. Sometimes these elevations are considerable, and very extensive; whilst at others they are circumscribed, and have a pustular or tuberculated appearance. If punctured, matter may be pressed from underneath the internal coat, varying in consistency from that of cheese to common pus †. Ulceration sometimes takes place on the surface of these elevations, and penetrating the middle coat of the artery gives rise to the formation of aneurism. Calcareous matter also is frequently deposited in the centre of these curdy eminences, and the surface of the artery sometimes exhibits an appearance as if these elevations had sloughed out in the same manner as the glandulæ aggre-

* Mollis succus erat, pultaceus, non dissimilis ejus qui in atheromate reperitur. HALLER, *Opuscula Pathologica*, obs. xlvii. p. 127.

† Plate 1. fig. 1.

gatæ of the intestines become converted into a cheesy matter, and slough. The deposition of this curdy matter between the coats of an artery sometimes proceeds to such an extent as to obliterate its cavity. I have observed this circumstance in the emulgent and femoral arteries of the same subject.

IV. A peculiar fungus sometimes grows from the semilunar valves of the aorta, which in appearance is very similar to those loose wart-like excrescences which form about the organs of generation, and are commonly termed venereal. This condition of the semilunar valves of the aorta is not very frequent, and a similar growth has been observed to take place from those of the pulmonary artery, and from the mitral and tricuspid valves *. In the majority of specimens which I have examined, the valves have been ruptured, and their edges studded with numerous soft fungous excrescences. These "*vegetations*," as Corvisart terms them, sometimes arise from narrow peduncles, and hang into the cavity of the vessel, whilst in other instances they have a broad base, and the appearance of soft unhealthy granulations. Corvisart considers them as the effect of syphilis †; but in a case which I shall relate, the absence of that disease throughout the life of the patient renders it impossible that they could

* Corvisart, *Essai sur les Maladies du Cœur*, p. 221, 225.

† Ibid, p. 217.

have arisen from that cause. I have not met with any instance upon record where a similar appearance has been observed in any of the branches of the aorta; but in the following case, a fungous growth which obliterated both the femoral artery and the profunda, was, in structure, similar to that of the excrescences which arose from the valves of the aorta.

CASE III.

A YOUNG man, about eighteen years of age, six weeks before his death was afflicted with violent pain in the head, and constant vomiting. His pulse was unusually strong and hard, and a quick vibratory pulsation was observed on the left side of the abdomen. The right leg was cold, and no pulsation could be discovered in its arteries. The action of the heart also was occasionally very indistinct. He was extremely feeble, his tongue and lips were covered with sordes, and he died like one destroyed by typhus fever. Upon inspection, the heart was observed to be of its natural size, and its cavities were of their usual proportions. Its muscular structure also was healthy. Two of the semilunar valves of the aorta were lacerated, and from their edges spouted numerous wart-like excrescences. Immediately below the valves, and at the origin of these excrescences, was an extensive ulcer, which had penetrated deeply into the walls of the ventricle

at the root of the aorta *. The passage of the blood into this cavity had dilated it into a small aneurismal recess, extending towards the right ventricle, from which it was separated only by the membrane lining the latter, and a few muscular fibres. A small quantity of pus was found underneath the edges of this cavity. The internal coat of the aorta was marked with numerous white specks. The right femoral artery, together with the profunda at the origin of the latter, were filled with a firm white substance, similar in structure to that of the excrescences which grew from the valves of the aorta. This substance adhered firmly to the sides of the vessel, which were healthy in that situation, but the cavities both of the femoral artery and of the profunda were obliterated by this fungous growth.

V. The deposition of a calcareous matter is so frequent an occurrence in the arteries of subjects advanced in life, that Bichat † estimates its existence in seven out of ten subjects above the age of sixty; and Dr. Baillie ‡ says, that at that age it is more frequently found to have taken place, than that the arterial system possesses its original healthy structure. The appearance which it gives to the surface of an artery depends entirely upon the extent

* Plate II. fig. 7.

† *Anatomie Générale*, tom. ii. p. 292.

‡ *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 133.

to which the deposition has taken place. Sometimes the internal coat presents numerous white specks of great minuteness; whilst, at other times, the calcareous matter is mixed with a curdy deposit, which produces a swollen and earthy condition of the internal coat. More generally, however, it forms a brittle scale or crust, which crackles under the finger like the shell of an egg*. Such incrustations do not observe any peculiar shape in their formation, but are irregular, and deposited both in a longitudinal and circular direction. Sometimes they form spiculæ, or eminences, projecting into the cavity of the vessel, and diminishing its calibre; and not unfrequently in the arteries of the lower extremities they occupy the whole circumference of the tube, forming distinct rings, which are connected together by the intervening membraneous portions of the vessel. In the early stage of their formation, they are often accompanied with a deposition of atheromatous or curdy matter underneath the internal coat, and they are frequently surrounded by extensive ulceration. In old subjects, however, they sometimes exist without any other morbid appearance in the coats of the arteries. In some cases they are probably detached from the sides of the vessel by ulceration, and, falling into its cavity, have produced those instances in which

* Scales of calcareous matter are seen upon the surface of the dilated aorta, represented in plate II.

loose calculi are reported to have been found in the heart and arteries *.

These incrustations appear always to commence in the substance of the internal coat, and generally on the external surface of that membrane; for there is almost constantly a delicate pellicle continuous with the internal coat, extending over the calcareous matter, and separating it from the blood passing through the vessel. This pellicle is sometimes deficient, or hangs into the cavity of the vessel, and the blood is in contact with the calcareous matter. In other instances all the coats of the vessel are involved in the disease, and are converted into a bony cylinder, in which no remnants of the original structure can be traced. Calcareous matter is frequently deposited in the membrane lining the heart, particularly around the tricuspid and semilunar valves, in which cases also the deposition appears to observe similar laws, and to commence on the external surface of the membrane, for a delicate pellicle generally intervenes between it and the cavity of the heart. Such concretions have been known, in some instances, to hang like polypi into the cavity of the heart, to the sides of which they were attached by membraneous peduncles †.

Various conjectures have been formed as to the

* Portal, *Cours d'Anatomie Médicale*, tom. iii. p. 85.

† Ibid, p. 84.

nature of these incrustations. Haller* thought them mere inspissations of the curdy matter so commonly deposited between the internal and middle coats of arteries. Some writers compared the lining membrane to periosteum, and these formations to bone, whilst others have imagined the affinity decided by meeting with pus in their circumference, which they conceived was the marrow. Such depositions are indeed commonly called ossifications, although the phenomena of their formation bears no resemblance to that of bone. They rarely appear at the same period of life, nor are they preceded by the existence of cartilage, which is constantly the case in natural ossification. They do not possess the fibrous structure of bones, for the calcareous matter is not distributed in any elementary texture, but deposited in the form of an irregular but homogeneous crust or crystallization, in the structure of which no peculiar arrangement is discernible.

I am indebted to Mr. Brande for a chemical analysis of these concretions. He found the specimens with which I furnished him to consist entirely of phosphate of lime and animal matter in the following proportions:

Phosphate of lime - - -	65,5
Animal matter - - - -	34,5
	100

* Caseosa primo, inde callosa, quasi coriacea, demum osseæ squamæ sit simillima. *Element. Physiolog.* tom. viii. p. 316.

The animal matter consisted chiefly of albumen, with traces only of gelatine; but the relative proportions of calcareous and animal matter will of course vary according to the progress of the deposition. No carbonate of lime could be discovered in their composition.

The frequency of the deposition of calcareous matter in the arteries of subjects advanced in life, has been a cause of much speculation; and some have conceived that in such instances it ought not to be regarded as a disease, but as the natural effect of protracted existence. Were this however the case, we should expect that its extent would be proportionate to the age of the subject, which is by no means the fact, for in the few recorded instances of longevity which have been accurately examined, this condition of the blood vessels was not very remarkable *. The effects, however, which it produces upon particular organs and the system in general, are highly interesting both in a pathological point of view and as serving

* On the other hand, calcareous matter is sometimes deposited in the arteries of very young subjects. My friend, Mr. George Young, possesses a temporal artery which he removed from an infant fifteen months old, in which the coats of the vessel are converted into a complete tube of calcareous matter. Portal observed a similar occurrence: *Cours d'Anatomie Médicale*, tom. iii. p. 133. See also SCARPA *on Aneurism*, WISHART's *Translation*, p. 89.

to explain many of the phenomena of old age. The decrepitude, the want of muscular power and energy, which characterize that state of man, may probably receive some explanation from considering that this state of the arteries is an almost constant attendant upon advanced life. The principal difference that is observable between the state of the various parts of the body in the young and the old, consists in the deficient vascularity of the latter. Thus, if a muscle be injected in a young and an old subject, the former will be found infinitely more organized than the latter. Now it is an ascertained fact, that a due supply of blood is necessary in every organ for a sufficient evolution of nervous power; and if the minute arteries are in old age rendered impervious, or their calibre diminished by these organic alterations of their coats, may not this elucidate the debility and decay of structure that attends old age? Although contraction and obliteration of vessels may frequently accompany lengthened existence, still I am unwilling to admit that a calcareous deposit in the coats of arteries ought to be regarded as the natural effect of age, for it is a very rare occurrence in brutes, many of whom, as the elephant, the eagle, &c. live to a very advanced period.

The deposition of calcareous matter in the coats of arteries is frequently productive of the most serious effects, either by destroying the continuity of that portion of the vessel in which the deposition

takes place, or by impeding the current of blood that is destined to pass through the artery for the supply of other parts. It excites irritation in the surrounding membranes as a foreign body, and thus gives rise to ulceration, which penetrating the internal and middle coats produces aneurism. At other times, the artery having lost its elasticity is ruptured by some sudden impulse of the circulating blood, and the disease is more rapidly produced. It also impedes the salutary operation of the ligature, by exciting ulceration and secondary hæmorrhage.

The deposition of calcareous as well as of atheromatous or curdy matter in the coats of arteries, is a frequent cause of passive hæmorrhages, either by exciting ulceration, or by destroying the elasticity of the tube, which in that state is easily ruptured by the impulse of the circulating blood. Hæmoptysis, in old persons, is frequently accompanied with this condition of the arteries, and I have rarely examined a case of apoplexy not arising from accidental violence, which did not exhibit a morbid condition of the arteries of the brain. This circumstance has been remarked by several writers upon the subject, particularly by Dr. Baillie*. The following case is selected from several others, because it exhibited this disease in the arteries of the brain to a very remarkable extent.

* *Morbid Anatomy*, p. 453.

CASE IV.

A ROBUST man, forty-five years of age, who had for some time exhibited symptoms of insanity, for several months had lost his speech, and was paralysed on his right side, was suddenly attacked with all the symptoms of apoplexy, namely, stertorous breathing, dilated pupils, total insensibility, loss of voluntary power, &c. In this state his wife gave him a purgative, and the next day he was so much benefited that he was able to sit out of bed. He continued in a state of paralysis and insensibility for ten days, when he had another sudden attack. The stertorous breathing and insensibility were much greater than formerly, and his pulse was quick, hard, and full. He was bled copiously, but the loss of muscular power prevented the administration of medicines, except by clysters. He died on the second day. In the removal of the skull cap a small wound was made through the dura mater, through which gushed about three ounces of yellow serum. A layer of coagulated blood was upon the surface of the pia mater covering the left hemisphere of the brain, and a similar layer adhered to the dura mater, which was elevated. From between these layers the serum had issued. The right hemisphere was also covered with a single layer of coagulum, which on both sides had a mottled appearance, and seemed to consist of the

fibrine of a former effusion, interspersed with patches of recent coagulum. The pressure of the serum on the left side had produced a depression in the brain, and the internal surface of the coagulum was beautifully grooved by the vessels of the pia mater. The substance and cavities of the brain were healthy, but all the arteries, both the larger ones on the basis of the brain, and their minute ramifications on the pia mater, were extensively diseased. In some places their cavities were obstructed by a deposition of atheromatous matter between their coats, and in others they were converted into complete tubes of a calcareous structure, the section of which afforded a wiry sensation. We could not discover the point which had given way, but there can be little doubt that the rupture was the consequence of this morbid condition of the coats of the arteries.

The same alteration of structure in the coats of arteries, which in other parts of the system, by causing ulceration and rupture, gives rise to aneurism, in the vessels of the brain produces apoplexy. Apoplexy, indeed, when it arises from the rupture of an artery, may be regarded as a species of aneurism. When the coats of an artery, in the extremities for example, are destroyed by ulceration, or ruptured by the impulse of the circulation, the effusion is generally restrained by the resistance of the surrounding parts, which are gradually ex-

panded into a sac confining the extravasated blood. But the soft and yielding structure of the brain is not capable of thus limiting the effusion. When, therefore, its arteries are ruptured, or their coats destroyed by ulceration, the blood is extensively injected into the surrounding structures, for there is here no cellular sheath which can oppose the effusion, and by its extensibility give origin to an aneurismal sac.

Calcareous matter is frequently deposited in the substance of the semilunar valves of the aorta. In the early stage of the disease the valves are generally thickened, and the earthy matter being deposited between the duplicature of membrane which forms the valves, it is separated by a delicate pellicle from the cavity of the vessel. But when the deposition is extensive, this membraneous covering is destroyed, and the blood is in contact with the earthy matter. The deposition is very irregular in its appearance, and generally commences at the base of the valves, and extends to their centre. At other times it begins in the little tubercle called the corpus Arantii, and extends along the floating margin of the valve to its attachment to the sides of the aorta. As the deposition accumulates, it produces the most serious consequences; for the rigid and immovable valves do not retain their situation close to the sides of the aorta, but project into its area; and their edges being united

by the earthy matter, the calibre of the vessel is surprisingly diminished*. Sometimes the valves are lacerated in the early stage of the disease, and their shrivelled remains are covered with irregular earthy concretions, which are attached to the sides of the aorta. Generally, however, the valves are united, and project into the vessel, leaving in some instances a mere chink or fissure for the passage of the blood; and I have, in several specimens seen the area which remained by no means equal to the calibre of the carotid artery.

This condition of the valves of the aorta produces more serious consequences than when a deposition of calcareous matter takes place in any other part of the arterial system. The body wastes, and the whole system suffers from the diminution which takes place in the quantity of blood which should pass through the aorta. The heart, however, is the seat of the more painful symptoms and effects, for being unable at one contraction to empty itself, and stimulated by the retained blood, it endeavours by frequency of action to compensate for the diminution of the stream. Its muscular parietes are consequently thickened, its cavites are enlarged, and the pulmonary and venous systems are dilated by the accumulation of blood.

* Plate 1. fig. 2.

The heart labours under this constant irritation, and is in a state of perpetual palpitation and exertion. Whoever has felt the horrible sensations produced by occasional irregularity in the action of the heart, will be able to estimate the distressful agony of those who suffer this incurable disease, the symptoms and appearances of which I had an opportunity of witnessing in the following instance.

CASE V.

A TALL thin man, about 60 years of age, had for years suffered symptoms of asthma. He had a slight expectoration of mucus, an irritating cough, and constant pain at the pit of the stomach. His pulse was very small and irregular. These symptoms increased; the pain became fixed, and was attended with constant palpitations of the heart. Temporary relief was obtained by the use of opium, and by regulating the state of the bowels. In the year 1811 his disease rapidly increased. The pulse at the wrist was scarcely distinguishable, his respiration became laborious and convulsed, and the pain in the situation of the heart was extreme. There was a violent pulsation in the epigastrium, which led some to think that his disease was an aneurism of the abdominal aorta. The pulse gradually became imperceptible; his extremities anasarcous, and his pain excruciating.

At length he died, worn out by long and painful sufferings.

The cavities of the pleura were found to contain about a quart of bloody serum, and the abdomen was distended by a similar effusion. There was no fluid in the pericardium. The heart was large, and its cavities were gorged with blood. The semilunar valves projected into the cavity of the aorta, and were covered with an irregular crust of calcareous matter. This deposition had united the valves, which appeared like a bony septum extending across the area of the vessel, and possessed no traces of their original structure. The opening which remained through this septum was a mere slit, and was in its whole extent much inferior to the calibre of the femoral artery in the same subject. The cavities of the right and left auricles and ventricles were enlarged, and their parietes thickened. The arteries in general were covered with earthy and atheromatous depositions.

The symptoms which characterize this disease consist in the violence of the action of the heart, and in the feeble and contracted state of the pulse. In the healthy subject, the pulse at the wrist possesses a corresponding force to that of the heart; but in the disease which we are now considering, this relative proportion is destroyed. The muscular structure of the ventricle is increased, and this increase of structure is attended with an in-

crease of force in its contraction. Hence arises the violent pulsation at the heart. But the strictured orifice of the aorta will permit only a very slender stream of blood to be thrown into the arteries, so that the pulse at the wrist is feeble, and bears no proportion to that of the heart. This comparative difference between the pulse at the wrist and that at the heart will, I conceive, in advanced cases, be sufficient to enable us to ascertain the existence of this disease; but the feeble and irregular state of the pulse, which is the principal symptom noted by authors, is not of itself sufficient for the diagnosis, because it accompanies many other organic derangements of this organ. Neither will the violent action of the heart, and the comparative weakness of the pulse in the arteries, be sufficient, unless we combine with it a knowledge of the symptoms of some other diseases, which are generally accompanied with violent action of the heart, and comparative weakness of the pulse of the arteries. In contraction of the left auriculo-ventricular opening, the pulse of the heart is considerable, whilst that of the arteries is feeble; so that it is impossible to distinguish this disease from obstruction at the orifice of the aorta, without a knowledge of those peculiarities which characterize the former affection.

Contraction of the left auriculo ventricular opening, I have in several instances observed to be

attended with a double pulse at the heart. The auricle first acts, and propels its contents towards the ventricle; but, from the constriction of the communication, the blood is not, as in the natural state, poured at once into that cavity. The ventricle, though imperfectly filled, contracts and forces the blood into the aorta. Thus there is a pulse caused by the action of the auricle, and another by that of the ventricle; so that for every pulsation at the wrist, two are perceptible at the heart. Nor is the auricular pulsation trifling; for in this disease the collection of blood in the auricle causes it to dilate and its parietes become thick and very muscular. The auricular pulse is not instantaneous, but continues for some moments, and is rather an irregular thrill, or "*bruissement*," as Corvisart terms it, than a distinct pulsation.

The double pulse at the heart may therefore, I conceive, be regarded as characteristic of contraction of the communication between the auricle and ventricle; and in the absence of this double pulse, violent action of the heart, accompanied by a small pulse in the arteries, may be considered as the diagnosis of obstruction at the orifice of the aorta.

The sensations which are produced by the deposition of calcareous matter in the valves of the aorta, attend also most other organic diseases of the heart and great blood vessels. The patient

complains of palpitation and irregularity in the action of the heart, producing occasional syncope. There is an intense pain at the scrobiculus cordis and underneath the sternum, generally extending down the arms and terminating in a sensation of numbness. The great cavities and the extremities become dropsical, the respiration is laborious, and there is often a violent pulsation in the epigastrium. These symptoms are the consequences of obstruction to the circulation; for the impediment is frequently so considerable, that if suddenly applied it would produce instantaneous death. Its gradual formation, however, enables the system in some degree to accustom itself to a derangement which, if suddenly effected, would at once subvert the most important functions of the economy. It is remarkable also, that the same extent of disease which in the valves of young subjects will produce the most serious consequences, in those of very old persons will not be attended with the same distressing symptoms. This circumstance is probably owing to the greater rapidity with which the disease accumulates in the former, and unhappily this is one of the most frequent seats of calcareous depositions in the blood vessels of adults and young persons.

A review of the morbid appearances sufficiently indicates the incurable nature of this disease. The treatment, therefore, can be only palliative. The

distressing symptoms are produced by the violent action of the heart, which is stimulated to constant exertion by the presence of accumulated blood. To diminish the cause of this irritation therefore is the principal indication, and this can be effected only by lessening the quantity of the blood. By this treatment we prevent the cavities of the heart from becoming surcharged, and the quantity sent into the ventricle is in some degree adapted to the current which can pass into the aorta. The irritating cause is thus diminished, and the action of the heart is tranquillized. It is almost unnecessary to add, that moderate but repeated bleedings and abstinence are the means of fulfilling this indication, to which may be joined the removal of all causes which exert a peculiar influence over the action of the heart.

When the deposition of calcareous matter has proceeded to a considerable extent, irregular eminences project into the cavity of the vessel, whereby its calibre is diminished, and in some instances completely obliterated. The impediment which is from this cause opposed to the circulation, will explain the wasting of structure and deficiency of nervous power which occur in organs, the vessels of which have undergone this change. It is now universally known, as I have already observed, that a due supply of blood is essential not only to the nutrition but also to the evolution of nervous energy,

and consequently to the right performance of the functions of every organ. It is upon this principle that it has been proposed to intercept the growth of tumours by diminishing the supply of blood by the ligature of their principal arteries. This practice was attended with some success in a case of bronchocele, in which Sir William Blizzard diminished the supply of blood by the ligature of the superior thyroid arteries. It is also upon this principle that Mr. Hunter, and subsequently Drs. Jenner and Parry, ascribed the symptoms of angina pectoris to the deposition of calcareous matter in the coronary arteries of the heart, whereby the stream of blood destined for the support of that organ is so much diminished, that its substance degenerates and wastes, its muscular power is lessened, and ultimately is insufficient for the purposes of the circulation. This condition of the coronary arteries does not, however, exist in every case which is attended with that train of symptoms to which have been applied the terms angina pectoris and syncope anginosa. Violent pain in the situation of the heart, extending down the arms, and terminating in a sensation of numbness, palpitation and irregularity in its action, with frequent syncope and difficult respiration, accompany almost all the organic diseases of that organ; at least I have witnessed them in dilatations and aneurisms of the aorta, contractions of the valves, adhesions of

the pericardium, and in active and passive aneurisms of the heart. Angina pectoris and syncope anginosa must therefore be regarded as terms designating rather a train of symptoms accompanying almost all organic diseases of the heart, than any particular morbid condition of that organ.

That a degeneration and wasting of the muscular structure of the heart attends an extensive deposition of calcareous matter in the coronary arteries, has been noticed by Jenner*, Parry†, and Baillie‡. The following cases exhibit the extent to which the muscular structure of the heart may be reduced from this cause, and prove how inadequate such a viscus must be to the due performance of its functions.

CASE VI.

An elderly woman, who suffered much from nervous symptoms, had long complained of palpitations and irregularity in the action of the heart, which occasioned frequent swoonings and vertigo. Whilst attending divine worship, she was suddenly seized with one of these fits, and died before assistance could be brought to her. The heart appeared unusually small. Its substance was extremely soft and flaccid. The parietes of either

* Parry *on Angina Pectoris.* † Ibid.

‡ Baillie's *Morbid Anatomy*, p. 45.

ventricle were not the eighth of an inch in thickness, and so soft and tender, that the finger could easily be thrust through any part of them. Their muscular substance was of a pale brown colour. The coronary arteries originated from one trunk, which was converted into a calcareous tube, as also were its ramifications, and it was with difficulty that a bristle could be passed down its contracted area. The other viscera were healthy. The preparation is in the collection of Mr. Langstaff, to whom I am indebted for its examination and the notes of the case.

CASE VII.

An old woman was brought into the dissecting room whose heart exhibited similar appearances, but to a much greater extent. The muscular substance of the left ventricle was not two lines in thickness, and the right was equally thin. There was not a particle of fat about it, and when inflated, the whole appeared a mere vesicle. The coronary arteries were filled with earthy matter. The aorta was larger than natural. The other viscera were healthy. The circumstances under which the case occurred precluded a knowledge of its history.

In the following remarkable instance, the degeneration of the structure of the ventricle had in one part proceeded to such an extent, that the remain-

ing fibres were unable to resist the force of the circulation, and death was the consequence of their laceration. The body was examined by Mr. Langstaff, to whom I am also obliged for this communication.

CASE VIII.

A CORPULENT lady, about 70 years of age, had for six years suffered severely from difficulty of breathing, attended with all the symptoms of asthma. In August 1811 she had an attack, apparently apoplectic, which was succeeded by a slight paralytic affection of the left arm and leg, from which she never entirely recovered. The difficulty of breathing increased after this attack. She had a constant pain under the sternum, a small and intermitting pulse, and the least anxiety, passion, or exertion, produced a state of syncope. In the night of the 27th of January 1812, she awoke with an excruciating pain in the region of the heart, her pulse was fuller than usual, and her respiration difficult and hurried. The pain was somewhat relieved by a slight bleeding from the arm. She continued restless and extremely agitated. Her pulse fell, her countenance became pallid, and she died suddenly about six o'clock on the following evening.

The lungs were perfectly healthy. The pericardium was distended by about twelve ounces

of dark coloured coagulated blood, which had issued from a rent in the anterior part of the apex of the left ventricle. This laceration was an inch in length on the internal surface of the heart, and extended about a quarter of that distance externally. The heart abounded in soft fat, and its muscular fibres were remarkably attenuated and flaccid, more especially around the fissure in the left ventricle. The coronary arteries were incrusted with calcareous matter, and the deposition was so extensive in the one distributed to the left side of the heart, as completely to obliterate its cavity. The membraneous lining of the ventricle was opaque; the semilunar valves of the aorta were natural, but there was an extensive crust of calcareous matter surrounding the origin of the coronary arteries. The internal coat of the aorta was converted into a cartilaginous structure interspersed with numerous calcareous flakes, some of which were partially detached, and projected into the cavity of the vessel. The deposition of earthy matter was so extensive between the origin of the inferior mesenteric artery and the division of the aorta into the two iliacs, that it formed a rigid and irregular tube, the diameter of which did not exceed one third of the natural dimensions of the vessel. The principal branches of the abdominal aorta had undergone a similar alteration, and the cavity of the superior mesenteric artery was obli-

terated by a substance which had the appearance of organized lymph. The communications between that artery and the inferior mesenteric were remarkably enlarged, as were also the epigastric and internal mammary arteries. The abdominal viscera were healthy, but loaded with fat.

There was a quantity of an opaque fluid between the arachnoid membrane and the pia mater, and the lateral ventricles contained about three ounces of lymph. The section of the right corpus striatum presented an irregular dark structure, dissimilar from the appearance of any part of the brain. This structure was considered as the consequence of an apoplectic effusion.

The obstruction which is offered to the passage of the blood by the deposition of calcareous matter in the internal coat of arteries, was noticed many years ago by Cowper* and Naish†, and has been adduced as a frequent cause of mortification, more especially in the feet of old persons. Experience has proved this condition of the arteries to be at least a constant attendant upon one species of gangrene, to which the extremities of old subjects are liable; and I have found the three principal arteries of the leg nearly obliterated by calcareous matter in two fatal cases of this disease.

* *Philosoph. Transact.* vol. xxiii. p. 1195.—xxiv. p. 1970.

† Ibid. vol. xxxi. p. 226.

But our knowledge of the power of collateral circulation in every part of the body will not allow us to admit the obliteration of the trunks as a sufficient cause of mortification, from deficient supply of blood. It is therefore necessary for us to remember, that the same disease may probably exist in the collateral branches, upon which it has produced similar effects. But if an extent of vessel be converted into a calcareous cylinder, it loses its elasticity and organic powers, so as to be unable to afford any assistance to the propulsion of the blood; and the existence of parts supplied by vessels in this state, constitutes a strong argument against the agency of the arteries in the circulation of the blood. The above observations on the cause of this species of gangrene, at once expose its incurable nature; and this state of the blood vessels renders the danger of amputation very considerable, unless fortunately the disease in the arteries does not extend to the part at which the ligature is applied.

The deposition of calcareous matter principally takes place in the arteries of the trunk, and in the branches of the carotid and iliac arteries, and more frequently in the second and third orders of vessels than in their ramifications. It seldom exists in the upper extremities; and it is remarkable, that although so frequent in the aorta, it is extremely rare that the pulmonary artery or its valves exhibit

this morbid appearance. Disease is seldom met with in the coats of the pulmonary artery, or in any parts of the system situated on the right side of the heart. I have never met with calcareous matter in the internal coat of the pulmonary artery, and in very few instances have seen this membrane opaque or distended with an atheromatous deposition. Bichat indeed denies that calcareous matter is ever deposited in the vessels that convey black blood*. I shall however, when speaking of the diseases of veins, adduce instances in which earthy matter has been met with in their coats; and the recorded instances of disease in the pulmonary artery and the right side of the heart are sufficiently numerous and authenticated to subvert the hypothesis which the distinction was intended to establish†.

* *Anatomie Générale*, tom. ii. p. 404.

† The following are references to cases in which disease has been found in the pulmonary artery, and in the parts situated on the right side of the heart:

Corvisart, *Essai sur les Maladies du Cœur*, p. 203, 209, 225.

Senac, *Traité de la Structure du Cœur*, tom. ii. p. 428.

Bonetus, *Sepulcretum Anatom.* lib. iii. sect. 21.

Morgagni, letter xlvii. art. 16.

Haller, *Opuscula Pathologica*, obs. li.

Burnet *de Polyposis Concretionibus Variorum in Pectore Morborum Causis.* Altd. 1729.

Some of the instances of disease in the pulmonary artery upon record had existed from birth, and may be more properly regarded as malformations. This was probably the case in the instance related by Morgagni, in which the pulmonary valves of a girl sixteen years of age were so connected together, "that they did but just leave a little foramen not bigger than a barleycorn, through which the blood was sent out*. The valves also at their upper part seemed cartilaginous, and contained a small point of earthy matter. Malformations of the pulmonary artery, which may be mistaken for disease, are not rare. I have examined two instances in which this vessel was closed at its origin, and the blood was sent to the lungs by the ductus arteriosus, and in a third specimen taken from a fœtus, the valves were irregular, and covered with a fungous growth.

Mohrenheim, *Wiener Beytrage*, b. xi. s. 215.

Pohl *de Ossif. Vasor. Præternatural.* Lips. 1774.

Baader, *Ob. Med. Incis. Iconibus Cadaverum Anatomicis Illustratæ.* Frib. 1765.

Bach in Richter's *Chir. Biblio.* b. viii. s. 498.

* A. Morgagni, letter xvii. art. 12.

SECTION V.

OF PRÆTERNATURAL DILATATION OF ARTERIES.

THE disease which I now intend to describe, consists in a prætematural and permanent enlargement of the cavity of an artery, and is generally attended with some morbid alteration of its coats. Although this disease has been noticed by many authors, and indeed by most of those who have considered the pathology of blood vessels, it has constantly been confounded with aneurism, and the want of an accurate acquaintance with its anatomy has given rise to much of the dispute in which the pathology of that disease has been involved. I hope however, when treating of the formation of aneurism, clearly to demonstrate the circumstances which characterize the difference between the two diseases, and at present shall proceed to describe the appearances and symptoms of the one in question.

Its most frequent seat is the ascending portion, and the arch of the aorta, which is in some instances dilated to an almost incredible degree, forming a large pouch or sac, generally commencing immediately above the semilunar valves. The coats of the artery form the boundary of the sac, and are remarkably thickened, and covered with

atheromatous and calcareous depositions. But there is some degree of uniformity in this diseased state of the vessel, for the same morbid alterations are found in various parts of the sac; and this circumstance appears to me to prove that the coats of the artery compose the disease, for it is the internal coat in which calcareous matter is deposited, and if we find that substance in all parts of the sac, it appears fair to infer that the internal coat enters into its composition, inasmuch as that "identity of disease indicates identity of structure*." This membrane indeed is much thickened, and resembles the peritoneum in an old herniary sac. Smaller sacs or pouches often grow from the sides of the great cyst, and are lined with a calcareous crust. At other times the dilated coats appear to have given way at some point, and an aneurism is thus as it were ingrafted upon the dilated artery. This circumstance has no doubt tended very much to confound the disease with aneurism, but in such cases the part at which the neck of the sac commences is very evident, and its lining does not present those morbid appearances peculiar to the coats of arteries. There is also another circumstance in which this disease differs from most aneurisms, namely, that such dilatations very rarely or never contain any lamel-

* Bichat, *Anatomie Générale*, tom. ii. p. 294.

lated coagulum. Mr. Allan Burns* has mentioned an instance in which some layers of coagulum were deposited; but the dilatation had in that case proceeded to such an extent, as to cause fissures in the coats of the sac in which the fibrine of the blood had been deposited. The dilatation often terminates abruptly at the arch of the aorta, but at other times it gradually diminishes. Sometimes the dilatation is partial, and occupies only one side of the vessel, which is expanded into a pouch, having much the appearance of an aneurism; but such partial dilatations very rarely contain lamellated coagulum. The essential differences between the two diseases will be considered when treating of the formation of aneurism.

This state of an artery is more frequent in the ascending aorta than in any other vessel; at least I have more frequently met with it in that situation than in any other part of the system. I have seen it however in the thoracic and abdominal aorta, and the angles at which arteries divide frequently exhibit a remarkable dilatation, more especially the divisions of the carotid and the iliac arteries. Sometimes also, although the vessel is considerably dilated, its coats do not present any remarkable alteration of structure.

This disease has been noticed by Senac†, Mor-

* Burns *on Diseases of the Heart*, p. 206.

† *Traité de la Structure du Cœur*, tom. ii. p. 407.

gagni*, Lieutaud†, Haller‡, Richerand‖, Scarpa§, Pelletan¶, and Blackall**: but all these writers, excepting the three last, have confounded it with aneurism. The symptoms with which it is attended when situated in the ascending aorta, are those which have been described as constituting angina pectoris, and are briefly detailed in the following cases.

CASE IX.

A STOUT man about 60 years of age had long complained of difficulty of breathing, great oppression in the chest, and frequent palpitations of the heart. He was occasionally subject to syncope, and preferred a recumbent posture. His pulse was very small, frequent, and intermitting, and his physician suspected that he had hydrothorax or some organic disease of the heart. In this state, whilst walking across his room, he suddenly fell, and instantly expired. The right ventricle of the heart was very much enlarged and flabby.

* Letter xvii. art. 17, 23. xviii. 28. lxvii. 21. lxiv. 12, &c.

† *Historia Anatomico Medica*, lib. ii. sect. 7.

‡ *Opuscula Pathologica*, obs. xviii.

‖ *Nosographie Chirurgicale*, tom. iv. p. 72.

§ *Treatise on Aneurism*, WISHART'S *Translation*, p. 55.

¶ *Clinique Chirurgicale*, tom. i. p. 88, 90, 91.

** *Observations on Dropsies and on Angina Pectoris*, p. 360, 364.

The aorta was dilated from its origin to the commencement of the descending portion into a large bag which would admit four fingers and the thumb with great ease. It had a gradual termination, and the lining membrane was thickened and covered throughout with earthy scales and atheromatous depositions. The semilunar valves were thickened and separated from each other. The left ventricle was large, but healthy. The aorta and left ventricle were gorged with recently coagulated blood, but there was no lamellated coagulum on the surface of the sac.

CASE X.

A TALL thin man, 60 years of age, had long been afflicted with symptoms of pulmonic disease. He had frequent syncope, and a weak irregular pulse. He was seized with sudden attacks of dyspnœa, which had much the appearance of asthmatic paroxysms. Bleeding and purgatives relieved these symptoms; but for six months before his death he could lie only upon his left side, which posture had become extremely irksome to him. He had a constant and copious expectoration of mucus; and at length, worn out by pain and the impediments to respiration, he died. The bronchia and lungs were loaded with mucus. The ascending aorta was immensely dilated, and formed

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a sac upwards of four inches in diameter. The dilatation commenced at the origin of the vessel, and terminated abruptly in the middle of the arch of the aorta. The internal membrane was irregularly thickened, fleshy, and covered with flakes of calcareous matter. In many places it presented fissures and ulcers, and just above the semilunar valves were two sacculi lined with thick crusts of earthy matter. From these sacs the coronary arteries originated. The semilunar valves were separated from each other in consequence of the dilatation of that part of the vessel, and were thickened and shrivelled. The abrupt termination of the disease in the arch of the aorta was very remarkable, and allowed a just estimate to be formed of the comparative size of this immense dilatation. The heart was natural, and the arteries in general did not present the appearances of much disease in their coats. The dilated aorta encroached upon the lungs, and pressed upon the division of the trachea. The arteria innominata and the left carotid and subclavian arteries originated from the superior part of the cyst*.

This condition of the ascending aorta appears to be generally induced by a previous disease in the coats of the vessel, in consequence of which it loses its elasticity, and does not

* Plate II.

regain its natural dimensions after the blood has passed through it. May it not in some cases be owing to a state of the fibrous or middle coat not unlike paralysis, for I have seen the vessel morbidly dilated without disease in its structure? Having, from whatever cause, lost its elasticity, the force of the circulation will increase the dilatation and establish the disease.

The symptoms which it produces are very similar to those that attend most organic diseases of the heart, but more so to those of aneurism of the aorta. The diagnosis between it and the latter disease is very obscure, especially as aneurism frequently exists at the same time. It may probably receive some elucidation by observing the peculiar weakness of the pulse, and the ease which the patient obtains by lying on the left side, so as to favour the passage of the blood into the descending aorta.

Death is generally induced in this disease either by the pressure which the sac exerts on important organs, as the bronchia or œsophagus; or, as is more frequently the case, by the collection of blood in the sac impeding the circulation and overpowering the heart, which is incapable of propelling the mass, and syncope or sudden death is the consequence. Sometimes the dilatation proceeds to such an extent that the sac bursts, and the blood is discharged into the cavity of the thorax.

Pelletan* relates a case in which the dilated vessel adhered to the lungs, into the cells of which it burst and proved fatal. In another instance it burst into the pericardium†, and in a third into the posterior mediastinum‡.

The treatment can only be palliative. The danger consists in the encroachment which the dilatation occasions on the neighbouring viscera, in its rupture from excessive expansion, or in the accumulation of blood in its cavity. The quantity of circulating blood, and the force with which it is driven into the sac by the action of the heart, must accelerate either termination. The indications therefore are to diminish the power of the heart, and the quantity of blood sent forth by it. These objects can be obtained only by bleeding and evacuants, which must be repeatedly employed to produce a continued effect. The treatment indeed is very similar to that of internal aneurisms, which will be considered hereafter.

I cannot avoid remarking, that many cases which are considered as instances of angina pectoris, of asthma, or as arising from some disease in the lungs, have their seat in an affection of the great blood vessels, and I shall conclude this subject with the following observation of Bichat. "La pratique me montre chaque jour que ces cas d'ossifi-

* *Chirurgicale Clinique*, tom. i. p. 89.
† Ibid. ‡ Ibid. p. 90.

cation, ceux d'anévrismes, et ceux des autres affections organiques dont le cœur est le siége, forment un classe de maladies chroniques presque aussi nombreuse que celle des maladies chroniques du poumon, sur lequel on regetoit en général tous les symptômes des maladies de poitrine*.

* *Anatomie Générale*, tom. ii. p. 296.

PART II.

ON ANEURISM.

When the coats of an artery have given way from any of the causes detailed in the preceding part of this treatise, such as ulceration, dilatation, or rupture, and the blood passes into a cyst formed by the condensed surrounding parts, so as to be out of the course of the circulation, the disease is termed aneurism. Aneurism is also said to exist when an artery being wounded, and the integuments above that wound being united, the blood is effused into the parts immediately surrounding the vessel, and forms by its pressure a sac which has no external opening. There are other diseases of the vascular system to which the term aneurism has been applied, but at present I shall consider only that variety which is produced by the disorganization of the coats of an artery from an internal cause.

SECTION I.

OF THE FORMATION OF ANEURISM IN GENERAL.

NOTWITHSTANDING the attention which has been given to this branch of pathology, there exists much uncertainty as to the nature of the parts which form an aneurismal sac. The question is simply this: Does aneurism ever consist in a general or partial dilatation of all the coats of an artery, or is it constantly produced by the destruction of all or most of these coats, and the formation of a sac by the influx of the blood into the sheath of the vessel and surrounding parts?

The controversies which have existed upon this subject appear to have arisen from a reluctance to admit the possibility of more than one cause in the production of the same effect, and from an adherence to opinions deduced from very imperfect observations. As the ancients did not examine morbid appearances by dissection, their opinions on all subjects which, like the present, can be decided only by anatomy, must be merely speculative, and of no value. It therefore can be of little consequence whether Ætius and Paulus did or did not describe aneurism as formed by a dilatation of the coats of an artery, or whether they agreed with most of the other Greeks and with the Arabians in defining aneurism to consist in the

rupture of an artery and the effusion of blood into the surrounding parts. Vesalius first applied anatomy to the investigation of disease, and he described an aneurism arising from the rupture of a dilated aorta*. Subsequent examinations by Sennertus†, Elsenerus‡, Silvaticus‖, Severinus §, Hildanus¶, Barbette**, and others, produced the doctrine that aneurism is universally caused by rupture of the proper coats of an artery. In the mean time, Fernelius†† advanced the doctrine that aneurism is produced by a dilatation of all the coats of an artery, similar to that dilatation which takes place in veins affected with varix. This opinion was supported also by Forrestus‡‡, Diemerbroek‖‖, and other writers. Further observations gave rise to a third opinion; and the cases recorded by Lancisi§§, Friend¶¶, Guattani***,

* Bonetus, *Sepulcret. Anatom.* lib. iv. sect. 2.

† *Opera Omnia*, tom. v. lib. v. pars i. cap. 43.

‡ *Acta. Nat. Curios.* an. 1. decad. 1. obs. 18.

‖ *De Aneurismat. Tractatio.*

§ *De Abscessuum Recorditá Naturá*, p. 195.

¶ *Opera Omnia*, centur. iii. obs. 44.

** *Opera Med. et Chir.* pars ii. cap. 16.

†† *Universa Medicina, de Extern. Corp. Affect.* lib. vii. cap. 3.

‡‡ See Friend's *History of Physic*, part i. p. 187.

‖‖ Ibid. p. 188.

§§ *De Motu Cordis et Aneurismatibus.*

¶¶ *History of Physic*, part i. p. 197.

*** *De Externis Aneurismatibus.*

and Morgagni*, seemed to prove that aneurism may be occasioned either by the rupture or by the dilatation of the coats of an artery, or by a combination of both circumstances, the dilatation having preceded the rupture. Systematic writers adopted this doctrine with regard to the formation of aneurism, and the different varieties of the disease were distinguished by the terms the true, the spurious, or the mixed aneurism. In the true aneurism a sac was described as formed by a dilatation of the coats of the artery; in the spurious, the coats of the vessel were said to be destroyed and the surrounding parts to form the sac; and the term mixed implied that variety in which the coats of the vessel were dilated to a certain extent, and subsequently by their destruction the true aneurism was converted into the spurious. Innumerable cases were recorded in which the sac appeared to be formed either by dilatation or rupture of the coats of the vessel, and upon these opinions and facts was grounded the doctrine generally received with regard to the formation of aneurism, until the publication of Scarpa's elaborate treatise. This indefatigable anatomist has revived the doctrine of Sennertus, and contends that aneurism is never produced by a dilatation, "but by a corrosion and

* Lett. xvii. art. 17. 25. xxvi. 14. xxvii. 14. xl. 26. l. 55, &c.

rupture of the proper coats of the artery, and consequently by the effusion of arterial blood under the cellular sheath, or any other membrane which covers externally the injured artery*."

Scarpa acknowledges the existence of that state of præternatural dilatation of an artery which I have described†, and mentions the frequency of its occurrence in the ascending aorta. He details some of the circumstances in which it differs from aneurism‡, although he admits that the two diseases frequently exist in the same vessel; and observes, that they have generally been confounded under the same denomination. The circumstances however in which they differ are so remarkable, that in a pathological point of view they require discrimination. I shall therefore offer a few remarks upon the subject before I detail the result of my own observations with regard to the formation of aneurism.

The disease to which I allude consists in a præternatural dilatation of the whole circle of an artery, and not in a partial or lateral distension of its coats. The root of an aneurismal sac however never or very rarely occupies the whole circumference of the vessel, but commences on one side by a neck which is in most instances

* *Treatise on Aneurism*, WISHART'S *Translation*, p. 53.

† See page 45.

‡ *Treatise on Aneurism*, WISHART'S *Translation*, p. 57.

narrower than the body of the tumour. An artery is sometimes præternaturally dilated without any morbid alteration having taken place in the texture of its coats. On the other hand, the structure of most aneurismal sacs differs essentially from that of a dilated artery. The former in general possesses a smooth membranous surface lined with coagulum, and in an advanced stage of the disease it exhibits no traces of the coats of the vessel; whilst the latter possesses an uniformity of structure, and is evidently composed of the coats of the artery, which are generally in a morbid condition. The passage of the blood is not so materially interrupted in a dilated artery as when it passes into the recess of an aneurismal sac, and consequently grumous clots and lamellated coagulum, which are almost constantly deposited in aneurisms, are never met with in dilated arteries. These observations show that there is an essential difference between the præternatural dilatation of the whole circle of an artery and an aneurismal sac, whether it originates in the destruction or partial dilatation of the coats of the vessel.

My own observations will not allow me to coincide with Scarpa in defining aneurism to be constantly produced by a destruction of the coats of an artery. On the contrary, the inspection of innumerable preparations of this disease contained in the principal museums of this metropolis, and

the more minute examination by dissection of various specimens of diseased arteries, and of aneurisms in the different stages of their formation, have produced a conviction in my mind, that although in most aneurismal sacs, especially in those which have arrived at a considerable size, the coats of the vessel have given way, yet in a great proportion of aneurisms the disease commenced in a partial dilatation of the coats of the artery. The evidence upon which this opinion is founded will be detailed in the following observations on the formation of aneurism, 1st, by destruction; and, 2dly, by a partial dilatation of the coats of the vessel.

A great proportion of the aneurismal sacs which I have had an opportunity of examining, were unquestionably formed in the manner which Scarpa has described, namely, by a destruction of the internal and middle coats of the artery, and the expansion of the external or cellular coat into a sac. The cellular coat at length gives way, and the sheath of the artery and the surrounding parts form the boundary of the tumour. When the internal and middle coats of an artery are divided, and air or water is injected into the vessel, the external coat bulges very considerably, and constitutes a small aneurismal sac. Nicholls exhibited this experiment to the Royal Society by injecting water into the pulmonary artery with such a degree of force, that he ruptured the internal

and middle coats, and distended the external *. I have frequently repeated the experiment by dividing the internal and middle coats of different arteries by the application of a ligature, which being removed, and the vessel forcibly inflated, the external coat has always exhibited a sufficient degree of dilatation to prove that it is more liable to yield and to be expanded into a sac, than to be ruptured by the impulse of the circulating blood. It appears therefore that when the internal and middle coats are destroyed, the sac is in the first instance formed by an expansion of the external coat of the artery: as the distention advances this membrane gradually gives way; the sheath of the vessel then restrains the effusion, and yielding in its turn, the surrounding parts, whatever may be their texture, form the walls of the extravasation. The inflammation that is excited in the coats of the artery by the primary disease, and subsequently in the surrounding parts by their distention, produces amongst them an effusion of lymph which glues them together, and prevents the effusion of blood into the cellular membrane. Thus is the sac formed, and the inflammation which exists within it produces an effusion of lymph with which its internal surface is lined like that of an abscess.

The causes which give rise to the destruction of

* *Philosophical Transactions*, vol. xxxv. p. 442.

the internal and middle coats of an artery, are ulceration and rupture. Ulceration, as I have already observed, is rarely met with in the coats of an artery which have not undergone some previous morbid alteration. It, however, frequently takes place in arteries the coats of which contain atheromatous or calcareous depositions. The internal coat first gives way; the destruction of the middle follows, and is accelerated by the infiltration of the blood amongst its fibres. The external coat becomes incapable of resisting the force of the circulation, and yields so as to form the sac of the aneurism. My friend Mr. Brodie favoured me with a diseased and thickened aorta, which exhibited these processes in a very early stage. The internal and middle coats were destroyed apparently by ulceration, and the external was expanded into a small pouch not larger than a pea.

The formation of an aneurismal tumour, in the generality of cases, is preceded by rupture of the internal and middle coats of the artery; the destruction of these coats by ulceration is a less frequent cause of aneurism. When the internal coat has undergone those morbid changes which I have described under the denominations of the steatomatous and cartilaginous thickenings, or when calcareous matter is deposited in its substance, it frequently cracks and hangs in scales into the cavity of the vessel. The disease is sometimes so extensive, that the middle

coat becomes involved in it; the fissure extends throughout its substance, and its fibres are readily separated by the impulse of the circulation. The blood thus comes in contact with the external coat, which is dilated into a sac, in the same manner as when the internal and middle coats are destroyed by ulceration. The aorta of a lady, whose case I have already detailed*, illustrated this stage of the formation of aneurism. The internal coat was throughout converted into cartilage, or covered with calcareous depositions. At the arch of the aorta there was a transverse rent about an inch in length, which had penetrated also the middle coat. The blood had insinuated itself between the middle and external coats, the latter of which was elevated into a tumour about two inches in circumference, and presented the appearance of a circumscribed ecchymosis. I conceive, that had the patient survived, this condition of the aorta would have given rise to the formation of an aneurism. A similar appearance was observed by Nicholls in the examination of the body of George the Second. "In the trunk of the aorta," says Nicholls, "we found a transverse fissure on its inner side about an inch and a half long, from which some blood had recently passed under its external coat, and formed an elevated ecchymosis†."

* Case viii. p. 39.

† *Philosophical Transactions*, vol. lii. p. 269.

The laceration of the internal and middle coats of the artery generally takes place during some violent exertion. Having lost its natural elasticity by the disorganization of its structures, the artery is unable to resist the impulse of the circulation; and hence patients generally date the commencement of their aneurisms from the occurrence of some accident or violent exertion. I have never, however, met with the laceration of the coats of an artery which had not undergone some previous morbid alteration, nor do I think it probable that any exertion which did not lacerate the surrounding parts could be sufficient to rupture the coats of a healthy vessel. Richerand* says, that by violently extending the leg upon the thigh the internal and middle coats of the popliteal artery are ruptured, and thus he accounts for the frequency of aneurisms in the ham. I have several times repeated this experiment, but have never lacerated the coats of the artery unless the degree of violence was sufficient at the same time to rupture the ligaments of the knee, an event which can rarely be supposed to take place in those accidents to which the origin of aneurisms is attributed. Again, the experiments of Dr. Jones† prove that the sudden laceration of the internal and middle coats of a healthy artery is not followed by the formation

* *Nosographie Chirurgicale*, tom. iv. p. 73.

† Jones *on Hæmorrhage*, p. 125.

of an aneurism. An effusion of lymph takes place, which renders the vessel more firm at that part. Mr. Hunter and Sir Everard Home* also peeled off the external coats of an artery in a living animal, to ascertain whether a deficiency of these coats would be attended with a dilatation of the internal, but they found that dilatation was not the consequence, and the effusion of lymph which took place upon the artery rendered it more firm and less capable of dilatation than in its natural state. The constant existence of disease in the coats of every artery which is the seat of aneurism, renders it probable, therefore, that the loss of elasticity predisposes to laceration from causes which would not be productive of that effect in a vessel which possessed its healthy properties.

The destruction of the coats of the vessel generally takes place in a transverse direction. Sometimes, more especially in the arteries of the third order, the whole circle of the vessel is separated, and in other instances the division is partial, and the artery appears as if it had been opened by an instrument†. Sometimes the destruction of the coats takes place in a longitudinal direction; sometimes it has a circular appearance, and its edges

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 144.

† Plate III.

form a partition between the cavity of the sac and that of the artery*.

Cases in which aneurisms appear to have been produced by destruction of the coats of the vessel, abound in surgical and pathological writings. It is sufficient however, in confirmation of the facts which I have stated, to refer to those recorded by Scarpa†, Morgagni‡, Lancisi‖, Guattani§, Desault¶, Warner**, and Home††, and to the plates of Scarpa‡‡ and Guattani‖‖.

But is every aneurism produced by a destruction of the internal and middle coats of the vessel, and does not a partial dilatation of these coats occasionally precede and give rise to their destruction? I believe that this is frequently the case. We have seen that the disorganization of the coats of an artery by destroying their natural elasticity will

* Plate VII.

† *Treatise on Aneurism*, WISHART'S *Translation*, p. 96, 100, 133, 137.

‡ Letter xxvi. art. 3, 15, 17—l. 2.

‖ *De Motu Cordis et Aneurismatibus*, prop. xxii. p. 240.

§ *De Externis Aneurismatibus*, Hist. xx. p. 75. v. p. 183.

¶ *Journal de Medicine*, tom. i. p. 87.

** *Philosoph. Trans.* vol. l. p. 363.

†† *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 171.

‡‡ See the plates in the original edition of SCARPA *on Aneurism*, two of which are copied in WISHART'S *Translation*.

‖‖ *De Externis Aneurismatibus*, plate II. and IV.

give rise to a permanent dilatation of the whole circumference of the vessel; and there is every reason to expect that a loss of its elasticity in a portion only of the diameter of the vessel, will give rise to a partial dilatation of its coats. Indeed the proofs of a partial dilatation of the coats of an artery, particularly of the aorta, are incontestably established by the possibility of tracing the coats of the vessel throughout the whole extent of the expansion; and by the existence of those morbid appearances in the sac which are peculiar to the coats of arteries.

In the year 1811 I dissected an aneurism of the aorta, which was removed from the body of a young woman by my friend Dr. Farre. The sac was as large as a small melon, and had proved fatal by bursting into the posterior mediastinum, and subsequently into the cavity of the thorax. This aorta exhibited the formation of aneurism by partial dilatation in three distinct stages. The internal coat was throughout inflamed, and presented a fleshy and irregular appearance. At the arch of the aorta there was a dilatation not larger than the half of a small pea. About two inches lower in the same vessel was a second dilatation which would have contained a hazel nut, and immediately above the diaphragm was the large aneurism which had proved fatal. I removed that portion of the vessel which contained the smallest

dilatation, and macerated it until its coats could be separated without violence. I found that the dilatation existed equally in the three coats of the vessel, and, when separated, each presented the appearance of a minute aneurism *. The second dilatation exhibited the same circumstances in a more advanced stage. The coats of the vessel were more intimately adherent to each other than in a natural state; but it was evident that the sac consisted in a dilatation of the internal, the middle, and the external coats of the aorta †. In the large aneurism, the disorganized internal and middle coats could be traced for some distance into the sac, when the parts contained in the posterior mediastinum and the vertebræ formed the remainder of the cyst. There can be little doubt that this sac commenced in a dilatation of the coats of the vessel similar to those appearances which existed in the superior portion of the artery, and the dissection appeared to illustrate the formation of aneurism, by partial dilatation of the coats of the artery ‡ in three distinct stages.

Those aneurisms which are situated at the origin of the aorta are generally formed by dilatation of

* Plate IV. fig. 1, 2, 3. † Ibid. fig. 4.

‡ The third stage in which the dilated coats of the vessel have given way and the surrounding parts confine the blood, is represented in plate IV. fig. 5.

the coats of the vessel. The internal surface of the sac in most instances exhibits some of those morbid alterations which are peculiar to the internal coat of an artery. The mouth of these sacs is generally larger than any other part of the cavity, and there is not that circumscribed margin between the artery and the sac which is constantly met with where aneurism is formed by destruction of the coats of the vessel. Aneurisms in this situation rarely arrive at that stage in which the coats of the vessel have given way from distention, and the surrounding parts contribute to the formation of the sac. The deficiency of cellular membrane and adjacent parts at the root of the aorta causes the destruction of the coats of the vessel to be generally attended with a fatal extravasation into the pericardium when the aneurism extends in that direction.

I have seen this partial dilatation in almost all the arteries which are subject to aneurism. It is by no means unfrequent at the division of the carotids and iliacs; and the few specimens of aneurism in the arteries of the brain which I have met with appear to have consisted in dilatation. The deficiency of cellular membrane within the skull causes the destruction of the coats of the arteries of the brain to be followed by an apoplectic extravasation, instead of the formation of an aneurismal sac; so that those morbid changes which in other

situations give rise to aneurism, in the vessels of the brain produce apoplexy.

Partial as well as general dilatation frequently precedes the formation of aneurism in the arteries of the extremities. A gentleman had a large aneurism in the thigh which had undergone a spontaneous cure. Upon examining the limb after death, the popliteal artery was found to be thickened, and covered with calcareous matter. A small pouch which would have contained the seed of an orange originated from the side of this artery. This little sac was evidently formed by a dilatation of the coats of the vessel, for the internal and middle coats could be traced in its circumference, and the former in that situation exhibited the same morbid appearances which it possessed in other parts of the vessel. A man died from the sloughing of an aneurism in the ham. In the femoral artery there was a small aneurism about as large as a walnut. The external coat was dissected from the surface of the tumour to a considerable extent. The internal and middle coats were evidently dilated, and contributed to the formation of the sac. The dilatation of these coats was gradual, and they continued for a considerable distance to form the sac, when they were inseparably blended with the surrounding parts. Both ends of the vessel exhibited the same appearances.

The sac which is formed by the dilatation of the coats of an artery, as it advances in size contracts firm adhesions with the parts that are in its immediate vicinity; so that when the dilated coats give way from distention, the effusion of the blood is restrained by these adhesions, and the sac continues to be formed in the same manner as when an aneurism is in the first instance produced by destruction of the coats of the vessel. Sometimes however the sac bursts suddenly before the adhesions are sufficiently firm to resist the impulse of the circulation; and in that case the blood is injected amongst the surrounding parts, and forms a diffused extravasation. An old man, who had uniformly enjoyed good health, whilst walking in the street, was attacked with a sudden pain, and immediately perceived a small swelling in the middle of the right thigh. The pain increased, the swelling became larger, and in a few hours the whole limb was œdematous. The tumour was compressible, but no pulsation could be discovered in it until a short time before death, when an indistinct thrill was perceptible. He became extremely feeble, the swelling increased, and he died in three weeks from its commencement. A quantity of grumous blood was found amongst the muscles of the thigh, which were separated to a considerable extent so as to form a large cavity on the anterior surface of the

triceps. The femoral artery communicated with this sac by a small round opening not larger than the calibre of the vessel. This opening was evidently the mouth of a small aneurismal sac, which had suddenly burst and given rise to the diffused extravasation, for the dilated and ruptured coats of the vessel were seen at the bottom of the cavity reflected upon the external surface of the artery. The original sac could not have been larger than a pea, and was formed by a partial dilatation of the coats of the vessel, which were throughout much thickened, and covered with calcareous matter*.

Sacs or pouches, evidently composed of the disorganized coats of the vessel, often arise from arteries, the whole cylinder of which has undergone a præternatural degree of dilatation. In the dilated aorta which was met with in Case X, two smaller sacs were situated immediately above the semilunar valves†. In some specimens which I have examined, the coats which form these small sacs have given way, and an aneurism has thus, as it were, been ingrafted upon a dilated artery.

There are on record numerous dissections of aneurisms in which the sac appears to have originated in a partial dilatation of the coats of an artery. The facts which have been stated may be considered as sufficiently conclusive to render

* Plate v. † Plate II.

it unnecessary to detail the authorities by which they are confirmed. It may be right however to state, that the preceding observations coincide with those recorded by Morgagni*, Haller†, Guattani‡, Verbudge‖, Monro§, and Hunter¶, most of whom have published engravings, which afford additional evidence of the truth of this doctrine.

The facts which I have adduced to illustrate the formation of aneurism, constitute a doctrine which derives additional confirmation from the observations of authors of opposite theories on the same subject. The error of these writers appears to have been, that they took too partial a view of the subject. They generalized from insufficient data. He who found a sac formed by dilatation, concluded that dilatation of the coats of the vessel was the only mode in which aneurism was produced. In like manner, he who found the coats of an artery lacerated or destroyed by ulceration concluded, and so far was justified, that

* See numerous cases in letter xxvi. Also letter xxi. art. 47. xl. 26. &c.

† *Opuscula Pathologica*, obs. iv. p. 13.

‡ *De Externis Aneurismat.* hist. v. p. 17. xviii. 67. xxiii. 85. Also plate I. fig. 1. II. 1. III. 1.

‖ *Dissertatio de Aneurismate*, p. 102. and plates v. and VI.

§ *Essays and Observations, Physical and Literary, of Edinburgh*, vol. iii. plate I.

¶ *Medical Observations and Inquiries*, vol. i. p. 325. and plate IV. fig. 1.

aneurism might be caused by destruction of the coats of an artery, but he was wrong in not admitting the possibility of some cause besides that which his own limited observation had pointed out to him. The explanation which I have given of the formation of aneurism is deduced from numerous observations of my own, and is supported by the authority of the most distinguished pathologists. It is a modification of the different doctrines which have been advanced upon the subject, and may be briefly stated as follows :

First; Numerous aneurisms are formed by destruction of the internal and middle coats of an artery, and the expansion of the external coat into a small cyst, which giving way from distention, the surrounding parts, whatever may be their structure, form the remainder of the sac.

Secondly; Sometimes the disease commences in the dilatation of a portion of the circumference of an artery. This dilatation increases until the coats of the vessel give way, when the surrounding parts form the sac, in the same manner as when the disease is in the first instance produced by destruction of the coats of an artery.

Aneurism, therefore, in some instances originates in a destruction or laceration, and in others in a dilatation, of the coats of an artery.

As an aneurismal sac advances in size, the surrounding parts become involved in its composition. Thus the bones, fasciæ, and various other structures, often contribute to its formation. The viscera perform a similar office when the disease is situated in the thorax or abdomen, and the membranes of which they are composed being distended to their utmost, the sac opens into their cavities. Thus aneurisms frequently prove fatal by bursting into the lungs, œsophagus, stomach, intestines, bladder, &c.

The size at which the tumour arrives depends upon the nature of the surrounding parts, and is very much determined by their extensibility, and particularly by the quantity of cellular membrane of which they are composed. When the disease is situated at the root of the aorta, and extends towards the cavity of the pericardium, the surrounding parts being thin and unyielding, the sac bursts before it has arrived at any great magnitude. In the brain also the arteries are involved only in the delicate membrane which forms the pia mater, and the soft and pulpy structure surrounding them is not capable of forming a sac. Hence when the coats of these vessels are destroyed, under circumstances which in other situations would give rise to the formation of aneurism, effusion and apoplexy are the consequences. The arteries of the brain are however subject to that variety of aneurism which is produced by general

or partial dilatation of the coats of the vessel. The internal carotid not unfrequently exhibits a remarkable dilatation of its entire calibre immediately that it enters the skull; and in Mr. Heaviside's Museum there is a specimen of two flasklike dilatations of both vertebral arteries immediately before their junction to form the basilary. In the following case of aneurism of the basilary artery, the sac was evidently formed by dilatation of the coats of the vessel, and it is one of those rare instances in which apoplexy is produced by the bursting of an aneurismal sac. I am indebted for the notes of the case and the examination of the preparation, to my friend Mr. Barnes of Exeter.

CASE XI.

A YOUNG woman, about 20 years of age, had been under medical treatment for a dropsical complaint. It was observed that she had a certain degree of dulness of apprehension, joined with deafness and tinnitus aurium. In the early part of her disorder leeches had been applied to her head on account of a pain there which had never been well defined. About a week before her death she was attacked suddenly, and without any apparent cause, by a violent vomiting and diarrhœa, with a most excruciating headach, a sensation as if the scalp were lifted by an internal force, indistinctness of vision, intolerance of light, &c.

She continued many days in excessive agony, the pupil being neither fixed nor dilated, and the understanding suffering only now and then a momentary eclipse. About twenty-four hours before death she fell into an apoplectic stupor.

The vessels of the pia mater were turgid with blood; all the ventricles contained clots of congealed blood, which were loose in their texture, and appeared as if recently extravasated. On the basis of the brain there was an extensive effusion of blood underneath the arachnoid coat, and the cerebral substance was in some places lacerated by the effusion. In detaching the coagula to discover the point from which the blood had proceeded, an opening was made into an aneurismal sac, to the outer investment of which the coagula adhered very closely. The sac was of the size of a horse bean, communicating with the trunk of the basilary, where it divides into the cerebellic and posterior cerebral arteries. It extended from this point forwards and upwards between the converging crura of the brain. It was thin and tender, bulging unequally in different parts. It was particularly thin, and had given way at the upper part, from which point the blood had forced its way into the ventricles and underneath the arachnoid membrane. The internal surface of the artery was of a red colour, and the sac appeared to be formed by a dilatation of the

whole tube at that point. It was irregular upon its internal surface, and contained a small clot of loose congealed blood *.

When an aneurismal sac invades the structure of a bone, the latter appears carious and corroded. This circumstance has been variously explained. Some of the older pathologists contended that the blood possessed a solvent power over bone, which was chemically dissolved when it came in contact with that fluid. Others have attributed

* Aneurism of the arteries situated within the skull is an extremely rare occurrence. Dr. Baillie, in the last edition of his Treatise on Morbid Anatomy (page 456), says, that he has seen but two instances of aneurisms formed in the arteries of the head and brain; and the only authentic case upon record that I have met with, is the one related by Sir Gilbert Blane, in the 2d volume of the Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge (page 193). In this case there were two aneurisms of the internal carotid arteries, about five-eighths of an inch in diameter, filling up the hollow on each side of the sella turcica. I have seen only two specimens of aneurism in the arteries of the brain. One was situated in the anterior artery of the cerebrum, and will be more particularly described when speaking of the spontaneous cure of aneurism. The other was the preparation which was sent to me by Mr. Barnes, the history of which I have related. It forms one of a series of cases of dropsy which has been published by Dr. Blackall of Exeter, who has also described the appearances of the disease within the skull.—See BLACKALL *on Dropsies*, p. 126.

it entirely to the attrition of the circulating blood. Hunter and Scarpa imputed it to the absorption of the bony matter from the pressure of the sac, which undoubtedly is sufficient to produce the effect, and constantly excites absorption of the soft parts in the vicinity of the tumour. The removal of the periosteum, which generally precedes the destruction of the bones, may also in some degree account for this circumstance. The vessels which supply the earthy matter being removed, the formation of bone does not continue, and that which remains presents a rough and carious appearance. Absorption however is unquestionably the principal agent in the production of this effect, for it is impossible by any other process to account for the irregularity with which the destruction of the bones takes place, and which gives to them the carious appearance. Aneurisms sometimes produce excavations in bones which are still covered with membranes. In such instances the bone is not divested of the source of its nutrition, and the blood is not in contact with its substance. Absorption therefore from pressure can alone have effected its removal. A few years ago I dissected an aneurism about as large as a hazel nut, which existed in the body of one of the lumbar vertebræ, and communicated with the cavity of the aorta, the coats of which were much thickened and destroyed, apparently

by ulceration, immediately opposite to this little sac. The cavity in the substance of the bone was lined throughout with a smooth polished membrane, so that it must have been formed by the absorption of the body of the vertebra, and not by a destruction of its periosteum, nor by the action of any solvent power in the blood. This condition of the bones in aneurism is, I believe, never attended with the formation of pus; at least the discovery of pus in its vicinity has not been remarked by those who have examined such cases. In this respect therefore it differs essentially from common caries or ulceration of bones. Exfoliation also is very rarely attendant upon it; from which circumstance one important practical observation is deducible, namely, that if the aneurism be cured, the bones will recover their healthy state without undergoing those processes which take place in the cure of caries or necrosis.

It is remarkable, that cartilage, whether merely subjected to pressure or exposed to the contact of blood in aneurismal sacs, is less rapidly destroyed than bone. This fact appears to indicate that it is not so liberally supplied with absorbents. It was noticed by Dr. William Hunter*, and I have had frequent opportunities of remarking it both in the intervertebral cartilages, in those of the ribs, and of the joints.

* *Medical Observations and Inquiries*, vol. i. p. 348.

The parts which enter into the composition of an aneurismal sac, retain, in some degree, their original properties. Thus, when the disease occurs in the neighbourhood of bones and the periosteum contributes to the formation of the sac, its vessels continue to secrete earthy matter, which in some instances has been deposited to such an extent as to form a considerable portion of the tumour. I believe that an extensive deposition of bony matter is rarely found in an aneurismal sac, unless the periosteum of neighbouring bones enters into its composition.

One of the first circumstances that generally attends the formation of aneurism, is the deposition of the fibrous portion of the blood upon the internal surface of the sac. This deposition takes place in successive layers, in a manner somewhat similar to the formation of the urinary calculus; differing from it, however, in this respect, that in the latter the innermost layers are first formed, whilst in the former the external lamellæ are first laid down. This coagulum appears to consist of the fibrine of the blood mixed with some red particles, and is deposited upon the surface of the sac in the same manner as it is deposited on the sides of a vessel in which recent blood is agitated. It does not appear to be produced by a general coagulation of the contents of the sac, being always, as far at least as I have observed, disposed in laminæ. In aneurisms there

is often found after death a quantity of congealed blood; but this, it must be observed, is very different from those concentric layers which line the surface of the sac. Those who have had opportunities of examining aneurisms, must have observed the laminæ of coagulum deposited on the internal surface of the sacs; instances being extremely rare, even in an early stage of the disease, in which this process has not commenced. It is found in small, as well as in large cysts, and appears in no degree to depend upon the size of the aperture by which the sac communicates with the artery. It is almost universally found in aneurisms in which the coats of the artery have given way, but in those sacs which consist either in a general or partial dilatation of the coats of the vessel I have never met with it. It has been supposed that the existence of lamellated coagulum might serve in some degree to discriminate the sacs which are formed in consequence of the destruction of the coats of an artery, from those which consist in a dilatation of the coats of the vessel. This observation, however, is not sufficient to constitute the diagnosis, because aneurisms which are evidently formed in consequence of the destruction of the coats of the vessel, sometimes, though rarely, do not contain lamellated coagulum. The circumstances that influence the deposition of coagulum in an aneurismal sac, exist also in other diseases where the blood passes out of the regular

course of the circulation. The deposition takes place in sacs which are formed in consequence of the destruction of the coats of an artery from an internal cause, as well as in those which occasionally arise from wounded arteries. In some diseases of the heart, in which the cavities of that viscus are præternaturally dilated, or their muscular parietes so much attenuated that they are unable to propel the whole of their contents, the fibrine of the accumulated blood is deposited in the cavity. I have seen two instances in which this had taken place: one was a dilatation of the left auricle, in consequence of a contraction of the auriculo-ventricular opening; the other was a case of passive aneurism of the left ventricle.

CASE XII.

I HAD an opportunity of inspecting the body of a young woman, concerning the symptoms of whose disease I was not able to obtain any satisfactory information. The lower extremities were anasarcous, and the cavities of the abdomen and thorax contained much serum. The heart appeared unusually large, but there was no serous effusion into the pericardium. The cavities on the right side of the heart were larger than natural, and were filled with congealed blood. The left auricle was excessively dilated. The opening by which it communicated with the left ventricle was so much diminished by a

ligamentous thickening of the lining membrane, and by a deposition of calcareous matter, that the point of the little finger could not be passed through it. The auricular portion was completely filled with lamellated coagulum, a nipple-like process of which projected into the sinus of the auricle. This deposition appeared in structure to be precisely similar to the lamellated coagulum which is met with in aneurismal sacs, and was but loosely connected with the membrane lining the auricle. The left ventricle and the aorta were healthy. The liver was gorged with blood. The intestines exhibited appearances of inflammation, and contained a great quantity of red gelatinous fluid.

CASE XIII.

A MAN, about thirty years of age, had long been afflicted with symptoms of disease of his heart. A few days before his death, when I saw him, his pulse was scarcely perceptible; his countenance was blue; his extremities cold; he complained of extreme pain and constriction across the chest; he had a hacking cough, and was constantly moaning and crying out. The heart was unusually large, and turgid with dark coloured blood. The left ventricle was of immense size; its parietes were very much attenuated, being in some parts not more than a line in thickness, especially towards the apex of the ventricle, at which part

a considerable deposition of fibrine had taken place similar to that which is met with in aneurismal sacs, but not so regularly lamellated. Between the columnæ carneæ a similar deposition had also taken place, and either hung in shreds in that situation, or appeared like loose granulations. The valves, the ascending aorta, and all the other parts connected with the heart, were healthy, as also were the other thoracic and the abdominal viscera. It appears very probable that in this case the muscular structure of the left ventricle was so much attenuated, and its cavity so much enlarged, that it was unable entirely to expel its contents, which consequently accumulated, and were placed as it were out of the course of the circulation.

Aneurisms, like abscesses, generally proceed towards the surface of the body; but in this respect they are very much influenced by the situation and the side of the vessel from which the disease originates. When the sac points externally it rarely or never bursts by laceration, but the extreme distention causes the integuments and investing parts to slough, and upon the separation of the eschar the blood issues from the tumour. A similar process takes place when the disease extends into a cavity which is lined by a mucous membrane, as the œsophagus, intestines, bladder, &c. In such cases the cavity of the aneurism is generally exposed by the separation of a slough which has formed upon its

most distended part, and not by laceration. But when the sac projects into a cavity lined by a serous membrane, as the pleura, the peritoneum, the pericardium, &c. sloughing of these membranes does not take place, but the parietes of the tumour, having become extremely thin in consequence of distention, at length burst by a crack or fissure, through which the blood is discharged. I have examined aneurisms that have burst into the cavities of the pericardium, the pleura, and the peritoneum, and the opening has always been formed by laceration, and not by sloughing: on the other hand, all the instances of this disease that I have seen, in which aneurisms burst upon the surface of the body, or into cavities lined by a mucous membrane, the opening has been the consequence of sloughing and ulceration, and not of laceration.

Some arteries are less liable to those diseases in their coats which predispose to the formation of aneurism than others. I have already mentioned how rarely disease is met with in the pulmonary artery. The arteries of the arm are much less frequently diseased than those of the trunk or lower extremities. In old persons calcareous matter is sometimes deposited in their coats, but I have never seen an aneurism which was not produced by accidental violence in any branch of the axillary artery. Aneurisms rarely arise from arteries of the fourth order, as the radial, the ulnar, the tibials,

the external carotids, &c. or from their ramifications, unless produced by accidental violence.

It is a remarkable circumstance, that aneurisms, and those diseases of the coats of arteries which precede the formation of aneurism, are much less frequently met with in women than men. The following table exhibits the comparative frequency of aneurisms in the two sexes in different cases of this disease, in which I have had an opportunity of seeing the patients during life, or of examining the parts soon after death. It exhibits also the comparative frequency of aneurisms in the different arteries of the body *.

	Total.	Males.	Females.
Of the ascending aorta, the arteria innominata, and the arch of the aorta	21	16	5
——— descending aorta	8	7	1
——— carotid artery	2	2	
——— subclavian and axillary arteries	5	5	
——— inguinal artery	12	12	
——— femoral and popliteal arteries	15	14	1
	63	56	7

* This table does not include aneurisms arising from wounded arteries, or aneurisms from anastomosis.

SECTION II.

OF THE SYMPTOMS AND DIAGNOSIS OF ANEURISM.

THE occurrence of a pulsating tumour in the vicinity of an artery will induce every cautious surgeon to suspect the existence of an aneurism. But there are many diseases which, from their situation or from other circumstances, may assume the symptoms of aneurisms, and in some instances aneurisms assume the appearances of other diseases. The treatment of these cases differs so materially, and an error in this respect may lead to consequences so dangerous, that an accurate acquaintance with their diagnosis is an object of the greatest importance. The circumstances that characterize the existence of an aneurism are much more complicated when the disease is situated in the thorax or abdomen, than when it exists in the extremities. Aneurisms in the thorax or abdomen frequently prove fatal before a knowledge of their existence is confirmed by that evidence which the appearance of the tumour externally generally affords, and the viscera with which they are surrounded are subject to a variety of diseases, many of the symptoms of which are common also to aneurisms of the aorta and its primary ramifications. I shall therefore, 1st, consider the progress and

symptoms of aneurisms in the thorax and abdomen; and, 2dly, I shall offer a few observations on those circumstances by which aneurisms, when situated in the extremities, may generally be distinguished from other diseases with which they are liable to be confounded.

When an aneurismal sac arises from the aorta immediately above the semilunar valves, the symptoms are very equivocal, because the tumour rarely arrives at such magnitude as to appear externally, and because the symptoms which it produces resemble those of some diseases of the heart. The pulse at the wrist is generally feeble and intermitting, the action of the heart is irregular, and attended with frequent palpitations; there is a sense of constriction across the chest, with an intense pain extending from the sternum down the arms, and a difficulty in respiration proportionate to the size of the tumour. When the sac arises from the anterior part of the ascending aorta, it projects opposite to the cartilages of the fifth and sixth ribs, which are gradually absorbed, and the tumour appears externally: when it originates from the anterior part of the arch of the aorta, the cartilages of the third and fourth ribs are consumed; and when it arises from the upper part of the arch of the aorta, or from the root of the arteria innominata, it ascends above the sternum and clavicles.

The progress of aneurisms arising from the superior part of the arch of the aorta deserves particular attention, because such cases are very liable to be mistaken for aneurisms of the subclavian or carotid arteries. The tumour first appears at the root of the neck, and gradually ascends. The sternum and the clavicles resist its protrusion in an anterior direction, and form a stricture at the root of that portion of the sac which projects externally. From this circumstance, the disease appears to originate above the chest, and in many instances the stricture formed by the resistance of the clavicles and sternum is so considerable, that it appears possible to tie the artery between the sac and the chest. I have seen several cases of aneurism arising from the superior part of the arch of the aorta, which protruded above the sternum and clavicles, and in one instance the space between the tumour and the sternum was so considerable, that it was proposed to tie the carotid artery for an aneurism, which dissection proved to arise from the origin of the arteria innominata, and from the arch of the aorta*. Had this operation been attempted, it is evident how disastrous must have been its termination; and the frequency of aneurisms arising from the supe-

* A case in some respects similar to this is related by Mr. Allan Burns. See Burns *on the Surgical Anatomy of the Head and Neck*, p. 32.

rior part of the arch of the aorta, renders a knowledge of this circumstance, with regard to their progress, an object of great importance.

Aneurisms arising from the thoracic aorta, by compressing the trachea and œsophagus, produce great impediments to respiration and deglutition, and are often mistaken for diseases of the lungs, or strictures of the œsophagus. When the disease is so far advanced that the bones are consumed, and the tumour projects externally, the pressure upon the internal parts is diminished, and the symptoms are mitigated. Thoracic aneurisms, however, frequently prove fatal by the pressure of the sac upon the important organs which are situated in its vicinity. As the tumour advances, it contracts adhesions to the surrounding viscera, and frequently bursts into their cavities. Aneurisms at the root of the aorta generally burst into the pericardium: sometimes they adhere to the pulmonary artery, and prove fatal by bursting into its cavity *. When the sac arises from the arch of the aorta, it frequently opens into the trachea †, and sometimes

* See a case recorded by Dr. WELLS in the *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. iii. p. 85.

† CASE XIV.

A ROBUST man, between thirty and forty years of age, had been for several months afflicted with an extreme difficulty of breathing, great pain and a sense of suffocation at the upper part of the thorax, a constantly irritating cough, and a copious expectoration of thin frothy mucus. His symptoms

into the œsophagus and pericardium *: when it grows from the descending aorta, it generally

resembled those of incipient phthisis pulmonalis, except the thin and frothy state of the expectoration and the absence of fever. His pulse was regular, and without intermission. During a violent fit of coughing, he suddenly brought up a great quantity of blood, and felt an alarming sense of suffocation: in a few minutes a second and more copious discharge of blood took place, and he expired instantly. Upon elevating the sternum, a portion of its upper bone, the first rib and the inferior surface of the right clavicle were observed to be absorbed, and the remainder of them formed part of the parietes of an aneurism. The tumour was as large as an orange: it filled the upper part of the thorax, and originated from the superior part of the arch of the aorta. It was lined with thick concentric layers of coagulum, and from its origin posteriorly the arteria innominata, the left carotid, and subclavian arteries arose. The disease had not appeared externally, but extended backwards, forming a large cyst, which adhered very intimately to the trachea. At its most distended part there was no coagulum: it communicated with the trachea by an aperture, in a part which had a sloughing and ulcerated appearance: this aperture was of sufficient size to admit a writing quill, and through it the blood had escaped. The lungs were healthy, but the air cells were very minutely injected with the blood which had escaped from the tumour into the trachea.

* CASE XV.

A SOLDIER, thirty years of age, had been afflicted during five months with an extreme difficulty of respiration. He had a slight cough, and a constant expectoration of thin frothy mucus. His pulse was frequent, but did not intermit. No increase during this time was observed in the symptoms, when, after eating a very hearty meal, he gave a deep groan, and instantly expired. Upon dissection, a large aneurism

bursts into the cavities of the pleura, the œsophagus, or the posterior mediastinum. The symptoms which attend thoracic aneurisms, in consequence of the pressure of the tumour upon the organs of respiration, are frequently mistaken for those of phthisis pulmonalis, or of some disease in the lungs. There is however one circumstance, independent of others, which in some instances will probably assist us in forming the diagnosis: in phthisis the expectoration is either puriform or thick and clotted; but in aneurisms, which are not accompanied with disease in the lungs, as far as I have observed, it always consists of a thin frothy mucus.

Many diseases in the thorax are liable to be mistaken for aneurisms of the aorta, in consequence of the præternatural pulsation with which they are

was found to occupy the whole of the arch, and a great part of the ascending aorta, beginning about half an inch above the semilunar valves. The sac extended in every direction, but more particularly downwards, and its origin above the valves was bounded by the pericardium, into the cavity of which it had burst by an aperture large enough to admit three fingers. The large branches of the arch of the aorta went off from the superior part of the sac, which contained about a pint of clotted blood, and a considerable quantity of lamellated coagulum. The trachea adhered firmly to the sac: the pericardium was full of blood.

I have dissected another case of aneurism occupying the whole of the arch of the aorta, which burst into the pericardium, so similar to the above, that it is unnecessary to detail the particulars of it.

accompanied. The principal of these diseases are, 1st, displacement of the heart by collections of matter or serum in the left side of the thorax, whereby that organ is thrust out of its natural situation, and pulsates against the right side of the chest, the sternum, or the cartilages of the ribs: 2dly, enlargements of the bronchial glands, or the existence of tumours within the chest, which being attached to the great blood vessels, pulsate at the root of the neck; and 3dly, an increased growth of the muscular substance of the heart, in consequence of which a violent and præternatural pulsation is produced in different parts of the thorax. When a præternatural pulsation is the consequence of a displacement of the heart, its cause is generally distinguishable by the absence of the pulse of the heart in its natural situation: when tumours or enlarged glands exist in the upper part of the thorax, their surface is generally more irregular than that of an aneurism; and an increased growth of the muscular substance of the heart is not only characterized by the peculiar violence of the pulse at the heart, but the effects which it produces upon the organs of respiration differ from those which are caused by the pressure of an aneurismal sac. Attention to these circumstances will generally assist us in discriminating the three diseases which I have mentioned from aneurisms of the aorta, and the other symptoms with which they are accompanied will in most instances be sufficient to establish the diagnosis.

When an aneurism arises from the aorta at the root of the cœliac artery, it contracts adhesions to the neighbouring viscera, and sometimes bursts into the stomach or duodenum. It is attended with frequent sickness, more especially after food is taken into the stomach, and by its pressure produces symptoms like those of stricture of the pylorus.

Various diseases are attended with a pulsation in the epigastrium, which renders them liable to be mistaken for aneurisms of the aorta or cœliac artery. Tumours growing from the diaphragm, pancreas, pylorus, and mesentery, and attached to the aorta and great blood vessels, sometimes produce a pulsation in the epigastrium. The symptoms peculiar to such diseases are in most instances sufficiently marked to enable us to discriminate them from aneurisms, and the pulsation is more general and diffused than in the latter disease. The inferior vena cava is sometimes præternaturally dilated: in such cases an undulatory pulsation has been observed in the epigastrium*. The heart is sometimes thrust downwards by collections of fluid, or by tumours in the chest, and its pulsation is distinguishable in the epigastrium. The absence of the pulse of the heart in its natural situation, and the impediments to respiration, will point out

* See BURNS *on Diseases of the Heart*, p. 265.

the cause of this symptom. In extensive adhesions of the pericardium, when the heart contracts, it pulls up the diaphragm, and the liver is thrown against the abdominal muscles so as to produce a pulsation in the epigastrium. The same effect is produced when violent action of the heart is caused by an increased growth of its muscular structure. A pulsation sometimes exists in the epigastrium, which is not the consequence of organic disease. It generally occurs in irritable and hypochondriac subjects, and is mitigated by the cure of the complaints with which it is accompanied *. In some instances I have thought it the consequence of the distention of the stomach with air, which, in that state, was thrown against the abdominal muscles by the pulsation of the great blood vessels. In the cases to which I allude, the pulsation was diminished by the eructation of air from the stomach †.

* Morgagni, letter xxiv. art. 34. — Baillie, in *Transactions of the College of Physicians*, vol. iv. p. 271. — Albers, in the *Edinburgh Medical and Surgical Journal*, vol. iii. p. 8.

† When an aneurism points in the loins, it often appears like a lumbar abscess, and instances have occurred in which it has been punctured as such. The opening, if carefully closed with adhesive straps, does not always prove fatal; and even when an aneurism has burst externally, life may frequently be prolonged by walling in the opening with adhesive straps and compresses, which may be additionally strengthened by a covering of plaster of Paris.

Aneurisms in the extremities are less liable to be mistaken for other diseases than when situated in the thorax or abdomen. Sometimes, however, aneurisms are not attended with pulsation, and are liable to be mistaken for various kinds of tumours. On the other hand, when they are attached to large arteries, various kinds of tumours sometimes possess a pulsation, which renders them liable to be mistaken for aneurisms. The following observations relate to some of the circumstances which will assist us in discriminating, First, aneurisms in the extremities which are not attended with pulsation, from other diseases with which they are liable to be confounded; and, Secondly, other diseases in the extremities, which are attended with pulsation, from aneurisms.

First: By compressing the upper part of the artery communicating with an aneurismal sac, so as to intercept its supply of blood, the tumour is generally rendered somewhat flaccid, whether it be attended with pulsation or not. If at the same time the tumour be compressed, its bulk may often be still further diminished; but, when the compression is removed from the artery and the tumour, the latter instantly regains its former dimensions. Continued general pressure with the hands will often enable us to discover, in some part of the swelling, a degree of pulsation, which was imperceptible upon a more partial examination. When the artery is compressed below an aneurism, so as to intercept the progress of the blood into the inferior arteries of the limb, the tumour is rendered more

tense, and its pulsation more violent: when the pulsation in an aneurism is indistinct, it may in this manner be rendered more evident; and, in aneurisms which are not attended with pulsation when the passage of the blood through the inferior portion of the vessel is uninterrupted, by compressing the artery below the tumour, pulsation will sometimes be produced in the latter.

Secondly: Other diseases, in consequence of their being attended with pulsation, are more frequently mistaken for aneurisms, than aneurisms for other diseases. Thus swellings in the neck, groin, ham, or axilla, sometimes pulsate, and have been regarded as aneurisms. There are two general observations which will often assist us in discriminating tumours that derive a pulsation from adjacent arteries from aneurisms. First; pressure upon the superior or inferior portion of the artery produces no alteration in the size of a tumour which does not communicate with the cavity of the vessel. Secondly; when moderate pressure is made upon the upper portion of an artery leading into an aneurismal sac, the blood enters the latter through a diminished opening, and of course in a smaller stream than usual: an undulatory or thrilling pulsation, like that which is observed in aneurisms arising from wounded arteries, or in aneurismal varix, is in this manner produced in the sac, instead of the equable pulsation which the tumour otherwise possessed: if, however, the tumour be not an aneurism, its pulsation is still uniform, though rendered less

violent than when a full current of blood passed through the artery.

Various kinds of tumours may possess a pulsation in consequence of their being situated either upon an artery, underneath an artery, or in consequence of the passage of an artery through them. When a tumour which derives a pulsation from a subjacent artery can be raised from its seat, the pulsation either ceases, or is diminished. The motion which a solid tumour derives from a subjacent artery, consists in an alternate elevation and depression of the whole mass, which a surgeon accustomed to the examination of aneurisms will often be able to distinguish from the general distention of the tumour which is produced by the influx of blood into an aneurismal sac at each pulsation of the heart. The motion, however, which the pulsation of a subjacent artery communicates to a tumour containing a fluid or pulpy substance, renders it more liable to be mistaken for an aneurism. When an artery passes over a solid tumour, the disease is not very liable to be regarded as an aneurism; but instances have not unfrequently occurred in which a large artery passing over a tumour containing a fluid or a pulpy substance has communicated a pulsation to the latter, which has caused it to be mistaken for an aneurism. In such cases a careful examination of the surface of the tumour will generally enable us to trace the artery passing over it. This observation, however, will not alone be sufficient to enable us to

discriminate the nature of the disease, because aneurisms sometimes arise from the posterior part of an artery, and, under such circumstances, the latter is stretched over the sac. When a tumour derives a pulsation from an artery which passes through it, the diagnosis will be still more obscure, and will depend in a great measure upon the history of the disease, and attention to the observations which are contained in the last paragraph. The diagnosis of aneurisms from anastomosis, when situated in the course of a large artery, will also be extremely difficult, unless the tumour, by projecting externally, presents the appearances which are peculiar to that disease.

SECTION III.

ON THE SPONTANEOUS CURE AND MEDICAL TREATMENT OF ANEURISM.

A KNOWLEDGE of the processes by which nature occasionally effects the cure of disease, is one of the most important objects of morbid anatomy. An acquaintance with this branch of pathology teaches us not to abandon every case for which we do not possess a decided remedy, and frequently indicates the means of assisting the processes which nature institutes for the reparation of disease. On the subject of aneurism, such an inquiry, at first sight, may appear superfluous. The great boldness with which modern surgery has extended the operations for the cure of this disease,

the decided powers of collateral circulation in all parts of the body, and the precision to which the application of the ligature has been reduced, seem to have established a decided remedy. These reasons may appear to render the inquiry of less importance in relation to aneurisms in the extremities. But when we consider that in many, if not in the majority of cases, the disease is situated in the thorax or abdomen; that surgery cannot extend its operations to these parts; that such cases are generally regarded as fatal; and if we find that art can sometimes arrest the increase of the tumour, and thus allow the progress of a natural cure, the inquiry may perhaps appear not altogether devoid of practical interest.

The processes by which the spontaneous cure of aneurism is effected, as far as I have been able to collect from the different cases upon record, and my own observations, are the following:

First, The removal of the whole tumour by sphacelation, in consequence of the extreme inflammation excited by the distention of the surrounding parts.

Secondly, The tumour assuming such a position, as to obliterate, by its pressure, the superior or inferior portion of the artery communicating with the sac.

And thirdly, The gradual deposition of the fibrine of the blood in the aneurismal sac and the artery leading into it, so as to render them impervious and

allow a subsequent process by which the tumour is removed. I shall proceed to consider under what circumstances these processes take place, and endeavour to deduce from the inquiry, the means by which art may contribute to their accomplishment.

I. When an aneurism in the extremities has acquired an immense bulk, it occasionally happens that the surrounding parts suffer so much from extreme distention, that gangrene supervenes, and the tumour degenerates into a large foul slough. If the powers of the constitution be sufficient to support the process, the disease is removed by repeated sloughings, and, when these are cast off, the sore granulates and the patient is cured. Hæmorrhage from the artery communicating with the sac, is, under these circumstances, prevented by the same process that secures the vessels leading to all parts in a state of gangrene. In cases of sphacelus the blood coagulates in the arteries and veins which supplied the parts, and their cavities are closed to a considerable distance by very firm plugs. The same effect frequently takes place in the artery leading into an aneurismal sac which is attacked by gangrene: it is therefore to be hoped, that in such instances the sphacelation may proceed to a sufficient extent to produce this effect. The formation of a slough on the most distended part of the tumour is the mode by which hæmorrhage generally takes place from aneurisms that appear externally: in most cases the sphacelation is not

sufficiently extensive to insulate the disease or close the artery. In the following instance, which occurred in the York Hospital at Chelsea, the cure of a large inguinal aneurism was effected by sphacelation.

CASE XVI.

An athletic dragoon, thirty-five years of age, ascribed to great exertions during a very severe field day, the origin of an aneurism in his right groin. The tumour increased rapidly: in a few weeks it was as large as a melon, and extended several inches above, as well as below, Poupart's ligament. It pulsated violently; its parietes were very thin, and its surface was inflamed. He was placed upon the lowest diet, and repeatedly bled from the arm, more particularly and largely when the pulsation in the tumour was much increased. On visiting him some time after he had been under this debilitating treatment, during which the tumour had acquired a greater degree of solidity, the integuments on its apex were observed to have become very livid, and were covered with numerous vesications, containing dark coloured serum. The pulsation about the same time ceased, and the surface of the tumour became black and flaccid. The man's death was momentarily expected. The parts became more discoloured, until at length a small opening formed in their

centre, from whence issued a large quantity of dark partly coagulated fœtid blood. The sloughing became more general, particularly around the circumference of the tumour. It extended in the perineum to the raphe, to the spine of the ilium, upon the abdominal muscles, and down the thigh. When the sloughs separated, many pounds of coagulum were discharged, until the whole cavity was cleared. The sloughing sac was gradually cast off, and, after a most tedious process, the sore assumed a healthy appearance; the edges began to granulate and discharge healthy matter. During this process, nature was left almost entirely to work the cure. The patient was extremely low; so much so once or twice, as to excite considerable alarm for his safety. His pulse could scarcely be felt, and he had frequent attacks of syncope. He was allowed wine and cordials. The immense chasm in his groin gradually filled up. The edges were approximated with adhesive straps; but it was more than twelve months before it had cicatrized. At the end of that time he was perfectly well, and remained in the hospital many months after the cure, during which time his health was good, and he suffered nothing from the remains of the disease but the inconvenience of so large a cicatrix.

In the following instance I had an opportunity of examining the parts in which this process had taken place.

CASE XVII.

A MAN had a large popliteal aneurism, which, at the time when he applied to his surgeon, was very hard, and void of pulsation. Shortly afterwards the tumour began to slough, and a firm mass of coagulum fell out. The surface of the sac continued to slough, but the patient's health rapidly declined, and he died under the process. Upon dissection, both the upper and lower ends of the artery communicating with the remains of the sac were found to be closed by plugs of coagulum. At the upper end, the plug extended to the origin of the profunda, and there was a small aneurism about the size of a walnut arising from the femoral artery, which was also completely filled with coagulum.

The rare accomplishment of the cure of an aneurism by sphacelation, and the exasperated circumstances of the disease, in which alone it can take place, render it an occurrence rather to be dreaded than looked forward to with any hope of a favourable result. The danger attending at all times the sphacelation of so large a surface, and the uncertainty of the process having proceeded to such an extent as to close the artery communicating with the sac, render all ideas of attempting by art a similar event, totally inadmissible. In former times, however, the actual cautery was recommended for

the cure of this disease; and Severinus* relates the history of a large aneurism in the groin, of which, after sphacelation had commenced, he promoted the cure by the application of red hot irons and caustic powders.

II. An aneurismal sac sometimes acquires such a position that the body of the tumour is reflected on the superior or inferior portion of the vessel which supplies the disease. Under these circumstances, such a degree of inflammation may be excited in the coats of the artery by the pressure exerted upon it by the sac, as to produce adhesion of its sides, and obliteration of its cavity. This occurrence is, I believe, extremely rare. Sir Everard Home has remarked, that " as the enlargement of the sac depends entirely on the force with which the blood is acted on by the heart, it does not, as at first, continue to swell out at right angles from the side of the artery, but is increased in a diagonal line between that and the course of the artery itself, from the force of the blood being applied in that direction; so that the sac is protruded along the outside of the artery, and by its pressure upon it, obliterates in many instances the lower orifice which communi-

* *De Abscessuum Recondita Natura*, p. 199.— Cases of aneurisms which were cured after the sphacelation and suppuration of the tumours are recorded by WISEMAN, *Chirurgical Treatises*, p. 73, 74. WILSON, in *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 268.

cates with the artery, and produces a total stagnation of blood in the sac*." Scarpa likewise observes, "it is not improbable, that in the cases of spontaneous radical cure of external aneurisms there concurs also a particular position of the aneurismal sac, by means of which, the sac being compressed by the ligaments and tendons, makes such a fold as to compress with an equable force, as in the artificial compression, the trunk of the injured artery at its entrance into the sac, and is therefore capable of producing the approximation of its sides; and at last, on the adhesive inflammation coming on, the tube of the artery is also obliterated, which constitutes the second stage of the radical cure of this disease†." Neither Sir Everard Home nor Scarpa, however, have given any cases or dissections which exhibit the actual existence of these circumstances. In the following case the appearances upon dissection render it probable that the obliteration of the femoral artery, and the cure of the aneurism, were effected by the compression of the superior portion of the artery between the sac and the femur.

CASE XVIII.

A GENTLEMAN, about thirty years of age, after a day's hunting, felt a pain in his thigh, which he

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 139.

† SCARPA, *on Aneurism*, WISHART'S *Translation*, p. 196.

considered as rheumatic. A month afterwards he perceived a small pulsating tumour in the course of the femoral artery, about four inches below Poupart's ligament. The tumour increased, and the leg and thigh became œdematous. He was bled copiously, and adhered to a low diet. Compresses were applied above the tumour in the course of the femoral artery, as high as Poupart's ligament, and the limb was rolled equally and tightly from the foot to the groin. The application of the roller increased the pain, and he suffered much from fever. This plan was continued for some months, when on a sudden the whole limb became extremely cold and benumbed, the tumour and upper part of the thigh put on a livid appearance, and serious apprehensions were entertained for the safety of the limb, which was hourly expected to become gangrenous. On the morning subsequent to this alarm, the pulsation in the tumour had ceased, but the livid colour and defect of sensation continued. The pain was abated, his fever was less, the warmth of the limb began to return, and the tumour to diminish. From this time he continued to recover; but it was long before the limb regained its natural sensation, or the œdema subsided. At the end of six months he suffered no inconvenience from the remains of the disease, except that the upper part of the thigh was four inches more in circumference than the opposite limb in the same situation. In this state he remained twelve years, when the swelling began

to enlarge, and was attended with a dull pain after violent exercise.

From this time the tumour gradually increased: when I saw him, twenty years after the commencement of the disease, it had grown to an immense size, but did not possess any of the characters of an aneurism. It had a firm fleshy feel, was void of pulsation, and no fluctuation could be discovered in it. It continued to increase for two years, when its apex sloughed, and a quantity of brown sordes was discharged, mixed with clots which had very much the appearance of lamellated coagulum in a putrid condition: no hæmorrhage took place. A large cavity was thus exposed, the surface of which assumed a sloughy aspect, and he died in consequence of the fever and irritation with which it was accompanied. Upon dissection, the sides of the tumour, consisting of a firm fleshy substance, were found to be in a sloughing condition, but no large blood-vessel communicated with the cavity. The femoral artery, before it penetrates the tendon of the triceps, was obliterated for the space of three inches. The body of the sac was reflected upwards upon the obliterated portion of the artery, which must have been compressed between the sac and the femur. Below the obliterated part the coats of the artery were remarkably diseased, and were dilated into a small sac in the ham *. In this case

* Plate IV. fig. 6.

it appears probable, that the cure of the aneurism was the consequence of the obliteration of the upper part of the artery, which was compressed between the tumour and the femur: a diseased action seems after some years to have commenced in the remains of the sac, which became a sarcomatous tumour, containing a grumous fluid mixed with clots, very like lamellated coagulum in a putrid condition *.

The pressure of an aneurismal sac has been known to obliterate an adjacent artery. Mr. Astley Cooper has mentioned an instance in which the cavity of the common carotid artery was obliterated by the pressure of an aneurism of the aorta, which extended up the neck by the side of the trachea †. I have met with a case in which the cavity of the left subclavian artery was obliterated by the pressure of an aneurism of the arch of the aorta. At the origin of the subclavian artery there was also a small aneurism, in which the processes of spontaneous cure by the deposition of lamellated coagulum had commenced in consequence of the obliteration of that portion of the

* I had an opportunity of seeing this patient whilst he was under the care of Mr. Freer of Birmingham, to whom I am also indebted for an opportunity of examining the parts which were removed after death. Mr. Freer has related the former part of the case in his *Observations on Aneurism*, p. 106: the sequel of it occurred subsequent to Mr. Freer's publication.

† *Medico-Chirurgical Transactions*, vol. i. p. 12, plate II. fig. 2.

vessel which communicated with the humeral extremity of sac. In this respect, therefore, the case in some degree illustrates that variety in the mode of cure which is produced by the pressure of an aneurism upon the inferior portion of the artery communicating with the sac. It is interesting also on account of the facts which it establishes with regard to the powers of collateral circulation, when the immediate source of nutrition in the upper extremity is destroyed by the obliteration of the subclavian artery before it has given off any branches.

CASE XIX.

A ROBUST soldier had for three years been afflicted with a very large aneurism of the aorta, which had caused the absorption of the whole of the upper bone of the sternum, and appeared externally in the form of a large pulsating tumour, extending nearly as high as the chin. Some months after he came under our care he died, worn out by the extreme impediments to respiration, and an inability to permit even fluids to pass his œsophagus; for, as was afterwards ascertained, the pressure of the tumour had produced sloughing and ulceration of a great portion of that tube. This great aneurism arose from the anterior part of the arch of the aorta, and filled the upper part, more especially the left side, of the thorax. The left subclavian artery, soon after its origin, was apparently dilated

into a tumour, resembling in its size and shape a very large chesnut. The aneurism of the aorta, by compressing a portion of this artery beyond the little aneurism, had caused its obliteration. The small aneurism was nearly filled with layers of coagulum, and the subclavian artery from the point where it emerged from this little sac was completely filled with a firm ligamentous substance. The vertebral, the internal mammary, and superior intercostal arteries, were very much contracted, and filled with a similar substance*. Thus had the cure of this little aneurism commenced in consequence of the pressure which the greater one had produced upon the subclavian artery. The inferior thyroid artery was not obliterated, and through it the blood must have passed in a retrograde direction into the trunk of the subclavian artery, which, although much contracted, was pervious from this point. In consequence of the removal of the parts, I was not able to trace the vessels by which the circulation was carried on, but it is probable that this object was effected by the branches of the inferior thyroid, the cervical and the supra scapulary arteries, all of which anastomose very freely with corresponding arteries of the opposite side, and with branches of the superior thyroid, the occipital and the vertebral arteries†. Nothing indicated the

* Plate VIII. fig. 1.

† The vertebral artery would derive a supply from its anastomoses within the skull.

obstruction during life; but it was remarked, that for many months before the death of the patient the pulse could not be felt in the left wrist*.

*A case in most respects similar to the above is related by M. Beauchéne in Corvisart, Leroux and Boyer's *Journal de Médecine*, tom. xx. p. 209. The scarcity of that publication in this country induces me to insert the following abstract of this important case. The Princess of G**, about sixty years of age, died of dropsy in the chest, and inflammation of the intestines. The calibre of the aorta was dilated to at least three times its natural extent. Its internal coat was of a deep red colour, very much thickened, and covered with calcareous depositions. The cavities on the left side of the heart were very much dilated, and their parietes attenuated. The right subclavian artery was slightly dilated, and contained from its origin to the part which passes behind the scalenus a dark coloured clot of the consistence of jelly. That portion of the vessel which passes behind the scalenus for the extent of an inch and a half, was filled by a very firm grey plug, which was impermeable to the blood, and adhered so intimately to the coats of the artery, that it could not be separated without their laceration. This portion of the vessel was intimately united to the surrounding parts by dense cellular membrane. Its calibre appeared contracted, but from its inferior side a small sac originated which rested upon the upper rib, and was filled with a friable clot of a dark grey colour. All the branches of the subclavian artery originated from that part of the vessel the cavity of which was obliterated, and were filled with grey clots that adhered very firmly to their coats, and extended various distances into their cavities from several lines to an inch. From the terminations of these clots the arteries were permeable, and received blood from the branches communicating with those of the opposite side, or from the corresponding side

In many of the instances in which artificial compression is said to have performed the cure of aneurisms, it is probable that it has done so by compressing the sac upon the superior or inferior portion of the artery by which it was supplied. The existence however of this peculiar position of the sac is a rare occurrence, and it must be regarded rather as an accidental circumstance than as an event which art can produce.

III. The obliteration of the sac in consequence of a deposition of lamellated coagulum in its cavity, is the mode by which the spontaneous cure of aneurism is in most instances effected. One of the circumstances which in the most early stage generally attends the formation of aneurism, is the establishment of that process which is the basis of its future cure. The blood which enters the sac soon after its formation generally leaves upon its internal surface a stratum of coagulum, and successive de-

below the disease. To the origin of the common scapulary, the axillary artery was filled with a clot which did not adhere to the sides of the vessel, and was of a light colour. From the origin of the common scapulary, which, as well as the circumflex arteries, was remarkably dilated, the other vessels in the limb were only distinguishable from those of the opposite side by the diminished size of their calibre.

The deficiency of the pulse at the wrist, when the cavity of the axillary artery was obliterated, has been noticed by Pelletan in a case of axillary aneurism which underwent a spontaneous cure.—*Clinique Chirurgicale*, tom. i. p. 80.

positions of the fibrous part of the blood gradually diminish the cavity of the tumour. At length the sac becomes entirely filled with this substance, and the deposition of it generally continues in the artery which supplies the disease, forming a firm plug of coagulum which extends on both sides of the sac to the next important ramifications that are given off from the artery. The circulation through the vessel is thus prevented, the blood is conveyed by collateral channels, and another process is instituted whereby the bulk of the tumour is removed, and the surrounding parts are enabled to resume their natural functions. The formation of the coagulum is but for temporary purposes. Like the plug which is formed in its extremity in consequence of the application of a ligature to an artery, it serves only to allow the accomplishment of those processes which could not take place whilst the parts were exposed to the impulse of the circulation. By the absorbents this coagulum is removed, and the sac and the artery from which it originates contract until the latter becomes an impervious cylinder, and the former a small fleshy tumour.

Numerous instances are recorded in which this process is noticed as having taken place, but its importance in the cure of aneurism, and the circumstances that influence its accomplishment, do not appear to have received that attention which,

in a practical point of view, they deserve. Desault* examined a popliteal aneurism in which a spontaneous cure had recently taken place. He found the sac filled with layers of coagulum, and a plug extending for the space of the breadth of three fingers within the tube of the popliteal artery. Petit† examined the remains of an aneurism of the right carotid artery which some years before had undergone a spontaneous cure. The tumour, which was originally as large as an apple, was at that time not larger than an olive. In the same artery nearer the heart was another aneurism, in which a similar process had commenced. The latter was nearly filled with concentric layers of coagulum which had a fleshy appearance, whilst the former was converted into a solid ligamentous knot. Dr. Baillie‡ met with an aneurism in the right carotid artery which was completely filled with fleshy layers of coagulum. In the left carotid of the same subject was a larger aneurism, in which the deposition of coagulum was proceeding to close the passage through the sac. Mr. Ford‖ found the sac and popliteal artery some weeks after the spontaneous

* *Journal de Med. de Paris,* tom. lxxi. p. 430.

† *Acad. Royal des Sciences de Paris. An.* 1765.

‡ *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge,* vol. i. p. 119.

‖ *London Medical Journal,* vol. ix.

cure of an aneurism in the ham filled with a firm hard substance; and Guattani*, at a still greater distance of time, describes it as degenerated into a solid ligamentous cord.

These authorities confirm the observations which I have deduced from the dissection of numerous cases which will presently be related with regard to the spontaneous cure of aneurism in consequence of the deposition of coagulum. The process may be briefly described as consisting of the three following stages;

First, the cavity of the sac is gradually filled with layers of coagulum.

Secondly, the circulation through the vessel is in most instances prevented by the extension of this coagulum to the origin of the next important ramifications that are given off by the artery from which the disease originates.

Thirdly, the coagulum is gradually absorbed, and the artery and the sac contract until the one becomes an impervious cylinder, and the other a small fleshy tumour.

It is a common opinion that the radical cure of an aneurism cannot take place without the obliteration of the artery from whence the disease originates†. It is probably owing to this idea that

* *De Externis Aneurismatibus*, Hist. iv. p. 16. tab. 1. fig. 2.

† Scarpa asserts "that it is a certain and incontrovertible fact in practical surgery, that a complete and truly radical cure

aneurisms of the aorta have generally been considered as incurable diseases, and consequently that so little attention has been given to their treatment. The danger which on many accounts must attend the obstruction of the circulation through that vessel, has led pathologists to imagine that a palliative treatment could alone be employed in aneurisms of the aorta, and that a radical cure could not be effected because it was impossible to preclude the ingress of the blood into the sac by the obliteration of that portion of the vessel from whence the disease originates. The facts which I shall relate will, I trust, be sufficient to prove; 1st, that a deposition of coagulum may take place in an aneurismal sac to such an extent as entirely to preclude the communication between its cavity and that of the artery from whence it originates; 2dly, that a sac thus filled with coagulum cannot prove fatal by rupture; and, 3dly, that the gradual absorption of its contents, and the consequent contraction of the sac, may proceed to such an extent as to effect the cure of the disease without any obstruction taking place

of aneurism cannot be obtained in whatever part of the body the tumour is situated, unless the ulcerated, lacerated, or wounded artery from which the aneurism is derived is by the assistance of nature, or of nature combined with art, obliterated and converted into a solid ligamentous substance, for a certain space above and below the ulceration, laceration, or wound." —*Treatise on Aneurism*, WISHART'S *Translation*, p. 188.

in the calibre of the vessel from whence it originated. Although dissection may not have demonstrated the process in that stage in which the absorption of the coagulum and the contraction of the sac have proceeded to such an extent that the only vestige of the disease was a ligamentous tumour, similar to the remains of aneurismal sacs which have been cured under other circumstances, and which sealed the opening in the artery, still it does not appear impossible that it may in some instances proceed to such an extent; and if the deposition within the sac renders it incapable of bursting, by entirely precluding the ingress of the blood, such circumstances may I think be fairly considered as constituting a cure of the disease. In the following cases this process had taken place to such an extent as to preclude the possibility of the rupture of the sac, which is generally regarded as the fatal termination of aneurism, and I shall subsequently adduce some cases in which the survival of the patients renders it probable that a permanent cure of the disease has taken place. The subject of the following case was under the care of my friend Mr. George Young, to whom I am indebted for the communication, and the examination of the morbid parts.

CASE XX.

A ROBUST man, about forty-seven years of age, died on the 16th of January, 1812. For some months before his death he had been afflicted with

great difficulty in breathing, a weazing cough, a quick, strong, and irregular pulse, difficulty in swallowing, a severe pain in the situation of the collar bone, extending over the dorsum of the scapula to its inferior angle, and a sensation of numbness and want of natural feeling in the right arm and fingers. Soon after the commencement of these symptoms a pulsating tumour was observed a little above the sternal extremity of the right clavicle, which was slightly thrust out of its articulation, and the shoulder was somewhat elevated. The symptoms were considerably increased by a violent exertion in the early part of the year preceding his death. The pain in the situation of the tumour was much increased; his breathing was remarkably quick, difficult, and weazing, and his pulse was full and hard. The great relief which had previously been obtained from copious and repeated bleeding was again procured by the same means, and the operation was frequently repeated to as great an extent as it was thought his strength would permit. He adhered to a very slender diet, consisting principally of weak broths and mild liquids. Great attention was paid to regulate the action of his bowels; bodily exertion, mental agitation, and all other causes which could augment the action of the sanguiferous system, were avoided. For several weeks before his death the difficulty in swallowing had subsided, the tumour had so far diminished as not to be visible, and scarcely to be felt above the clavicle. The shoulder

had resumed its natural situation, and the pulsation in the chest was surprisingly diminished. The difficulty of breathing however increased. He had a constant hacking cough, which was frequently accompanied with a croup-like noise, and a copious expectoration of viscid frothy mucus, which was effected with extreme difficulty. These symptoms were always relieved by blood-letting; but the constant irritation of the cough and the increasing difficulty of breathing gradually exhausted the powers of life, and he died with all the symptoms of an inveterate asthma. The tumour which had been observed above the clavicle had entirely disappeared before his death.

Upon dissection an aneurism was found to have existed at the anterior part of the arch of the aorta close to the origin of the arteria innominata. It had passed upwards and outwards, and its apex was situated immediately below the top of the sternum, to which it slightly adhered. This tumour originated from a circumscribed opening in the aorta about three quarters of an inch in diameter, for which space the coats of the vessel were evidently deficient. The sac, which was now contracted to the size of a small orange, was consequently formed by the surrounding parts, and the left subclavian vein and the vena cava superior adhered very firmly to it posteriorly. Laterally it was very intimately connected with the trachea, which it had thrust to the left side, and upon which it had exerted

so much pressure as to reduce its tube to nearly one half of the natural dimensions. The œsophagus was not so much displaced as the trachea. Internally, the sac was filled with the most firm and fleshy coagulum that I have ever met with, having evidently been deposited for a very considerable time. The sac was nearly filled with this fleshy mass, so that it was impossible that it could have given way in any direction. This coagulum did not in the least degree extend into the cavity of the aorta so as to encroach upon its calibre, but was arched over the opening into that vessel so as to leave a small cavity which would have contained half of a small walnut, and permitted the passage of the blood into the arteria innominata which originated from the inferior and posterior part of the sac, or rather the sac had commenced at the origin of that artery. The arched termination of the coagulum had a membranous appearance on its surface. The aorta throughout was somewhat dilated, and its internal coat was of a deep red colour, opaque, thickened, and puckered. In some places it was converted into a cartilaginous and steatomatous structure. In the thorax, immediately above the diaphragm, there was a regular conical dilatation of the aorta which extended about three inches. The other viscera were healthy *.

* Plate VI.

CASE XXI.

A MILLER, about fifty years of age, had for five years before his death been afflicted with severe symptoms of asthma. Various medical men considered him as labouring under that peculiar asthma to which those who follow his occupation are subject. His symptoms however were always relieved by copious bleedings. The above was all the information which could be procured, relative to his disease, when the body was examined. The lungs were perfectly healthy. A small aneurismal sac originated from the posterior part of the arch of the aorta close to the root of the arteria innominata. This sac was about the size of a common walnut, and the coats of the aorta were deficient at its base for the space of about the size of a sixpenny piece. The cavity was completely filled with very firm layers of coagulum resembling more the appearance of boiled muscle than any other substance with which I am acquainted. The opening by which the sac had communicated with the aorta was blocked up by the base of the coagulum, but the cavity of that vessel was not in the least diminished. The tumour adhered posteriorly to the trachea, which was thrust out of its natural position, and had assumed a very remarkable curve, by which its calibre was reduced to one half of the natural dimensions. The coats of the aorta were thickened, and covered with steatomatous and earthy depositions.

CASE XXII.

Some years ago I had an opportunity of examining the body of a young woman who died with an aneurism of the arch of the aorta. The tumour appeared above the sternum, rather on the right side. It was large and pulsating, and her death was hourly expected to take place from the rupture of the integuments, which were very thin and livid. From the employment of repeated bleedings, rigid abstinence and quietude, the pulsation in the sac became gradually less violent; its size diminished, it became more solid; and, in short, in a few months she was so far recovered, as to be able to resume her former employment. In twelve months she returned, complaining of a constant irritating cough, attended with a copious expectoration of frothy mucus, which in the course of a few weeks destroyed her, the tumour at that time being scarcely to be felt above the sternum. Upon dissection, an aneurism was discovered of the size of a small apple, originating from the anterior part of the arch of the aorta, the pressure of which upon the trachea had produced the fatal cough. This tumour was very solid, and when divided was found to be composed of firm but distinct layers of coagulum, of a whiter and more fleshy appearance than it is met with in recent cases. The cavity of the sac had formerly communicated with that of the aorta, by an opening about the size of half a crown, now closed by the base of the coagulum, the surface of

which had a smooth and membranous appearance. But the coagulum did not in the least extend into the cavity of the aorta, the calibre of which was consequently not obstructed by the process of cure which had taken place in the aneurism. The coats of the aorta were thickened, and considerably dilated, particularly at the origin of the arteria innominata and at the root of the aneurism, which appeared to be formed by the destruction of the dilated coats of the vessel*.

CASE XXIII.

An old man died suddenly with a very large aneurism that appeared externally at the root of the neck. Upon dissection, the whole of the ascending portion and the arch of the aorta were found to be enormously dilated, and would with ease have admitted the whole hand. At the upper part the dilated coats had given way, and the surrounding parts formed that portion of the sac which projected externally. The dilated coats of the vessel were much thickened, and covered with calcareous depositions, but there was no lamellated coagulum in the sac. The calibre of the descending aorta was of its natural dimensions, but its coats were much diseased. At the origin of the cœliac artery there was a small aneurism, the cavity of which was com-

* I had an opportunity of seeing this and several other cases through the kindness of my friend Mr. Freer of Birmingham. Several of them are contained in Mr. Freer's *Observations on Aneurism*. The above is related at p. 109.

pletely filled with firm lamellated coagulum, which entirely closed the communication between the sac and the artery, and terminated by a smooth surface, which had a membranous appearance at the part where the coats of the artery had given way. The cœliac artery went off from the sac, and its orifice was completely obliterated by the coagulum. The obliteration extended about an inch into the cavity of this vessel, and the superior mesenteric artery was also obliterated in consequence of a thickening and deposition of atheromatous matter which had taken place in its coats*.

I have not met with any cases of aneurism of the aorta upon record, in which the deposition of coagulum is noticed as having taken place to such an extent as in the instances above related. Pathologists, indeed, have regarded the deposition of coagulum rather as an accidental circumstance, than as the primary agent in the cure of aneurism. They have consequently been content with simply noticing its existence, and describing its lamellated texture, without regarding its importance as the means by which the force of the circulation is removed from the sac, and the fatal termination of the disease by rupture is prevented. In the course of this treatise, I think, however, that I shall be able to demonstrate that in the cure of most aneurisms, whether effected spontaneously or by the assistance of art,

* Plate VII. fig. 1.

the obliteration of the cavity of the sac by a deposition of coagulum is of primary importance, by allowing that subsequent process of contraction and obliteration which could not take place whilst the parts were exposed to the impulse of the circulation. The only instances that I have met with, in which the cavity of an aneurismal sac arising from the aorta appears to have been completely filled with coagulum, and the process of cure to have taken place in the same manner as in those which I have related, are recorded by Corvisart. "At the anterior part of the arch of the aorta," says Corvisart*, "I observed a small dark coloured tumour of the size of a nut, which I took at first sight for an enlarged bronchial gland, but wishing to thrust the knife into its substance, my attention was fixed by the resistance that I met with in dividing the external membrane of this tumour. I examined it more attentively, and ascertained with certainty that it was a fibrous sac which at its base adhered intimately to the coats of the aorta, with which at the same time it appeared in some degree connected. It was formed of an external membrane, evidently of a fibrous texture, about two lines in thickness. This cyst contained a substance less firm than suet, of a deep red colour, very similar in other respects to the old clots of blood which adhere to the internal surface of aneurismal sacs. I conceived that

* *Essai sur les Maladies du Cœur*, p. 313.

this cyst communicated with the cavity of the vessel to which it was attached, but it was in vain that I searched for the communicating aperture. The external coats of the aorta at the point corresponding with the cavity of the cyst were destroyed, and the thickness of the vessel at that part was infinitely less considerable than in any other situation. Having opened the aorta longitudinally, I could not perceive any aperture of communication, but I saw a grey and livid spot that corresponded with the base of the cyst." In the course of the same vessel, just above the cœliac artery, there was a smaller cyst in other respects precisely similar to the one above described. In another subject also, Corvisart found three similar tumours upon the abdominal aorta, and one or two connected with the common iliac arteries*. The appearances in these cases were so precisely similar to those exhibited in Case XXIII, that I think there can be little doubt that they were aneurismal sacs filled with lamellated coagulum so as to obliterate their cavities, without the extension of the deposition into the tube of the aorta. The appearance of the base of the coagulum sealing the aperture in the aorta was similar to that which was exhibited in the case to which I have referred, when the vessel was laid open in a longitudinal direction; but the size of the tumours renders it probable that the cure had proceeded to a greater

* *Essai sur les Maladies du Cœur*, p. 314.

extent in the cases recorded by Corvisart than in any of the instances that I have had an opportunity of examining.

In the spontaneous cure of aneurisms arising from arteries of the second and third orders, or from their ramifications, the deposition of coagulum generally takes place to such a degree as not only to obliterate the cavity of the sac, but also to extend into the tube of the artery, which is obstructed both above and below the part from which the disease originates to the next important ramifications. The circulation through the vessel is thus prevented, and the blood which should pass through the trunk is conveyed to the parts which it is destined to supply by collateral channels. I have dissected a small aneurism arising from the femoral artery a little above the tendon of the triceps in which this process had taken place. The sac was completely filled with firm concentric layers of coagulum, which extended upwards as far as the origin of the profunda, and downwards to the termination of the popliteal artery. In the dissections also recorded by Desault, Petit, Baillie, Ford, and Guattani*, the deposition of coagulum had proceeded to such an extent as to obliterate the cavity of the artery from which the disease originated. It is possible, however, that an aneurism arising from any other artery may undergo

* See page 116.

a spontaneous cure in the same manner as I have described it to be effected when the disease originates from the aorta; namely, by a deposition of coagulum in the sac to such an extent as completely to obliterate its cavity without obstructing the tube of the vessel with which it communicated. Scarpa* dissected an aneurism formed by a wound of the brachial artery in the operation of bleeding. A dark coloured tumour as large as a nut was attached to the external surface of the artery by cellular membrane. "The brachial artery," says Scarpa, "had preserved exactly its natural diameter, and on opening it on the side opposite to the dark coloured body, there was distinctly perceived on the inside of it the cicatrix of the puncture which had been made in it by the lancet. On dividing this dark body vertically, it appeared to be formed by a firm and large cellular capsule, although it was originally only a continuation of the soft cellular substance that surrounded the rest of the brachial artery. Within this hard rigid sac there was a clot of compact blood nearly of a triangular figure. One of the angles of this clot of a whitish colour was formed rather by the fibrous substance than by the crassamentum of the blood. This angle insinuated itself into a fossa formed by the separated lips of the wound of the artery, which this clot

* *Treatise on Aneurism*, WISHART's *Translation*, p. 351; and plate II. fig. 2, 3, 4, 5.

closed up like a plug, and adhered firmly to the lips of it." Dr. Jones* made an aneurism by wounding the carotid artery of a dog in a transverse direction. Eighteen days after the experiment the animal was killed. On cutting through the integuments, a circumscribed, hard, oviform portion of coagulated blood was found lying immediately over the wounded part of the artery, to which it was confined by a cyst, adhering to the vessel and the surrounding parts. On cutting open the artery posteriorly, its canal was found to be completely pervious throughout. The wound in the artery preserved its original circular appearance, and was covered by the base of the coagulum before mentioned. Through the kindness of my friend Dr. Farre I was permitted to examine the preparation which was the result of this experiment, and found that the coagulum, which was of a firm lamellated texture, not only obliterated the cavity of the sac, but completely closed the aperture of communication between it and the artery. Cases of aneurisms arising from wounds of the brachial artery in the operation of bloodletting, in which a similar process of cure had taken place, are also recorded by Petit†, Foubert‡, and Saviard‖. In the following instance, a

* *Treatise on Hæmorrhage*, p. 96; and plate IV. fig. 3 and 4.

† *Mem. de l'Acad. Roy. des Sciences de Paris. An.* 1735.

‡ *Mem. de l'Acad. Roy. de Chirurgie*, tom. ii. p. 535.

‖ *Journal des Sçavans*. An. 1691.

small sac, which originated from the anterior artery of the cerebrum, was completely filled with firm coagulum which did not extend into the cavity of the vessel. The cure of this little aneurism was therefore effected in the same manner as in the instances which I have related.

CASE XXIV.

An incurable lunatic, fifty-seven years of age, who had been for seventeen years confined in Bethelem Hospital, died on the 19th of August, 1811. The integuments of the skull were remarkably loose, and could be pinched up like the skin of a quadruped. The head was very small; the forehead declined considerably; and the parietal bones were much flattened. The pia mater was opake and thickened, and there was in some parts a quantity of milky fluid between it and the arachnoid membrane. The vessels of the brain were turgid, its substance was firm, and when divided exhibited numerous bloody points, particularly in the right hemisphere. The lateral ventricles contained four ounces of a transparent fluid, and the vessels upon their surface were remarkably full. The cavity of the septum lucidum was also filled with serum. Calcareous matter was deposited in the coats of the internal carotid and basilary arteries. When the vessels of the brain were removed, a small tumour, about as large as half a pea, of a dark colour,

was observed to be attached to one of the anterior arteries of the cerebrum about an inch from its origin. This tumour was very hard and appeared intimately connected with the coats of the vessel. On laying open the artery in a longitudinal direction opposite to the tumour, a small circular opening was observed in its coats corresponding to the part at which the tumour was attached. This opening, which occupied but a small portion of the circumference of the vessel, was completely plugged by the base of a firm lamellated coagulum, which filled the cavity of the sac, but did not extend into that of the vessel, so that the continuity of the latter was restored, and the ingress of the blood into the former was prevented. The appearance of this artery was very like that which Scarpa has delineated in an aneurism of the humeral artery. The preparation is in the possession of Mr. Langstaff, to whom I am indebted for its examination *.

In the cases that I have adduced in which a spontaneous cure had taken place, it will be ob-

* Plate VII. fig. 2 and 3. Since the note at p. 78 was printed I have seen a third specimen of aneurism in an artery of the brain. The sac was as large as a cherry, and originated from one of the anterior arteries of the cerebrum. It did not contain any lamellated coagulum, and by its rupture produced a fatal apoplexy. The patient was a young man, and the history of his case is very similar to that of Case XI. p. 76.

served that the aneurism was produced by a partial dilatation or destruction of the coats of the artery. It is possible however for a cure to be effected by a deposition of coagulum where the sac is produced by a dilatation or destruction of the whole circumference of the vessel. In the following instance a deposition of coagulum had taken place throughout the whole circumference of the interior of the sac; a small canal only was left through the centre of the mass, which afforded a passage for the blood, and preserved the continuity of the tube. I am indebted to Mr. Astley Cooper for the notes of the case and the examination of the preparation.

CASE XXV.

A STRONG muscular man, thirty-four years of age, was admitted into Guy's Hospital with a very large aneurism in the axilla, which had thrust up the clavicle and destroyed the ribs. At the same time he had a pulsating tumour in his right groin; but of so little importance did he consider this swelling, that although it had existed six or seven years he had not thought it necessary to obtain advice or relief for it. He imputed its origin to a violent exertion in raising a piece of timber, and said that it soon arrived at its present size. It was solid to the touch, possessed a strong pulsation, and was larger than a common bubo. It continued

in the same state until the death of the patient, which happened a short time after his admission into the hospital. The tumour in the groin was removed, and a longitudinal section of it exhibited the following appearances. The femoral artery, from its origin to the extent of more than three inches, was dilated into a sac, which was lined on all sides with very firm layers of coagulum which had a fleshy appearance. This deposition did not completely obstruct the passage through the sac, for an irregular canal, which in some places was larger than the natural calibre of the artery, still remained through its centre. The coagulum that formed the immediate boundary of this canal was more condensed than in any other situation, and exhibited a membranous appearance, similar to what was observed in Cases XX., XXII. and XXIII. In this instance, therefore, a spontaneous cure had been effected by a deposition of coagulum, through the centre of which a canal remained by which the continuity of the tube was preserved*.

The facts which I have related elucidate the importance of the deposition of coagulum as a primary agent in the spontaneous cure of aneurism, and are sufficient to prove that the cure of this disease may take place without the obliteration of the cavity of the artery from which it originates. A

* Plate VII. fig. 4.

knowledge of this fact is an object of great importance, because, without its occurrence, it would be in vain to hope for the cure of aneurisms of the aorta.

The circumstances that indicate the commencement of this mode of spontaneous cure, are the greater degree of solidity that the tumour acquires, and the gradual diminution of its bulk. The pulsation still exists if the cavity of the artery be not at the same time obliterated, for the sac and the coagulum that it contains are moved by the alternate dilatation and contraction of the artery to which they are connected. In this respect the part is placed in a similar condition to that of any other tumour attached to the coats of an artery, and pulsates from the same cause. In Case XXV. although it was six or seven years from the commencement of the cure, the tumour possessed a strong pulsation. When the cavity of the artery however is obliterated, the pulsation of the aneurism of course ceases. The greater degree of solidity that the tumour acquires, and the contraction of the sac when it adheres to the larynx or trachea, are frequent causes of death, even when the cavity of the sac is obliterated, and there is no danger of its proving fatal by rupture. This effect has been thus explained to me by Mr. George Young: When the tumour is large it thrusts the trachea to one side, and their points of contact become firmly united. As the tumour shrinks the adherent portion of the

trachea is bent over it, and receives a corresponding indentation. Thus the cavity of the tube is greatly diminished, which circumstance explains the alarming sense of suffocation and violent paroxysms of coughing which finally exhaust the patient. In other instances the general pressure is so considerable as to encroach upon the cavity of the tube, and thus produce extreme impediments to respiration. In this respect the effect is precisely the same as when enlarged glands or various morbid growths exist in the vicinity of the trachea. The greater solidity which the tumour acquires as the deposition of coagulum advances, will account for the increase of the impediments to respiration as the obliteration of the cavity of the sac proceeds, and these effects increased to such a degree in Cases XX. and XXII. as to prove fatal.

The symptoms that attend the spontaneous cure of aneurism in the extremities, in which at the same time the cavity of the artery is obliterated, are detailed in the following cases.

CASE XXVI.

A WOMAN, about sixty years of age, was afflicted with a tumour as large as a pullet's egg situated above the middle of the right clavicle, and possessing a pulsation synchronous with the pulse at the wrist. The skin upon the tumour preserved its natural appearance, but the arm was rendered nearly useless, for the slightest exertion produced consider-

able pain. This tumour had been gradually increasing for five months, but had not till lately caused much inconvenience. The pain and anxiety with which it was now attended produced a great degree of emaciation. An operation was not deemed advisable from the advanced condition of the disease, and the effects which it had produced upon the clavicle and neighbouring parts. The disease with all its painful symptoms became rapidly aggravated. At the end of two months the swelling had extended half way up the neck, and somewhat below the clavicle. The situation of this bone was marked by a depression crossing the tumour horizontally, though the bone itself could not be felt. The skin became livid, and the pulsation much more violent. The arm was swelled, the veins turgid, the numbness of the fingers increased, the pain in the shoulder was aggravated, and she was utterly unable to lie down in bed from a sense of immediate suffocation. The pulse was rapid and weak, and she had no sleep except when it was procured by opiates. After about forty-eight hours of more than usual suffering, with pain so violent that (to use her own expression) she felt as if her shoulder was being torn from her body, the severity of the symptoms gradually abated. The tumour insensibly diminished in size, the pulsation became fainter, the pain subsided, and by degrees she recovered the free use of her arm. About eighteen months after the cure had taken place, there remained a small hard incompressible tumour.

The middle of the clavicle had been partially absorbed, and had thrown out rough projecting points which formed the inferior boundary of the tumour. No pulsation could be felt below the clavicle; it was very feeble in the axilla, but in the middle of the arm was as strong as in the opposite limb. Two arteries, supposed to be the transversalis colli and supra scapulary arteries, were to be felt on the surface of the tumour. The arm was of its natural size, and she could use it for common purposes, but violent exertion produced pain in the situation of the tumour.

CASE XXVII.

An unfortunate woman, about thirty-six years of age, who had led a very dissolute and abandoned life, in September 1809, whilst intoxicated, conceived she sprained her knee, and in a short time afterwards perceived a tumour in the ham attended with a strong pulsation. A swelling of the leg soon followed, with violent pain, which was increased by the exertion of walking so much as to prevent her moving thirty yards without resting. The swelling and pulsation in the ham gradually increased during the space of several months. On examining the tumour at this time it was decidedly an aneurism of the popliteal artery. The pulsation was perceptible through the bed linen, and the tumour became more flaccid upon pressing the upper part of the artery. It was as large as a common

sized orange, and caused intense pain and numbness in the whole limb. She refused to submit to an operation which was proposed to her; the limb was rolled with moderate tightness from the toes to the middle of the thigh. Her sufferings rendered her unable to pursue her depraved course of life, and poverty enacted temperance and low diet. She was confined to her bed, and was frequently bled and purged. At the end of two months the tumour became more solid; the pulsation was less violent, and shortly afterwards it ceased entirely. The swelling then began gradually to subside, and in a little time was scarcely perceptible. These changes were attended with a corresponding decrease in the swelling of the limb, and an abatement of the pain. At the end of six months she could walk without any other inconvenience than a sense of weakness in the leg.

CASE XXVIII.

An athletic man, about thirty-seven years of age, the guard of a mail-coach, ascribed the origin of a popliteal aneurism to a violent exertion in jumping. A small pulsating tumour was shortly afterwards felt in the ham, which gradually increased, and in a few weeks acquired the size of a small melon. No doubt could be entertained as to the nature of the disease, and as the man was reluctant to submit to an operation, the limb was gently rolled from the toes to the top of the thigh; a compress was applied

in the course of the artery, and a spare diet with constant rest, and frequent bleedings were had recourse to. The tumour for some time continued to increase, and the pain which it occasioned was extreme. At length the pulsation became obscure, and gradually ceased. At the same time the tumour became hard and incompressible. It diminished in size, and in some weeks was scarcely perceptible. The man recovered, and there remained only a slight stiffness of the limb when I saw him two years after the occurrence of the disease*.

I shall now consider what are the means by which art can promote the deposition of coagulum so as to effect the cure of aneurisms. From the facts that I have stated, and from the cases upon record to which I have referred, it is evident that

* This case is related by Mr. Freer in his *Observations on Aneurism*, p. 108. The following are references to cases of aneurisms of the femoral and popliteal arteries which underwent spontaneous cures:

Guattani, *de Externis Aneurismatibus*, Hist. iii., iv., and v.

Morgagni, letter l. art. 10.

Ford, *Medical Journal*, vol. ix.

Desault, *Journal de Med. de Paris*, tom. lxxi. p. 430.

Abernethy, *Surgical Observations on Aneurism*, p. 252.

Pelletan, *Clinique Chirurgicale*, tom. i. p. 115.

Home, *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 156.

Wilson, Ibid. vol. ii. p. 268.

Freer, *Observations on Aneurism*, p. 107, 108.

this is not only the process by which the spontaneous cure is in most instances effected, but also that it is the only mode by which that event can take place in aneurisms of the aorta. That peculiar position of an aneurismal sac in which it is capable of obliterating by its pressure the cavity of the artery supplying the disease, is a rare occurrence, and must be regarded as an accidental circumstance, rather than as an event which it is in the power of art to produce. The cure by sphacelation also cannot be accomplished without considerable risk to the life of the patient. The deposition of coagulum, indeed, seems to be of primary importance in whatever mode the cure of aneurism is effected; for if that event takes place by sphacelation, the cavity of the artery must be closed by coagulum; and I shall subsequently demonstrate, when treating of the operation for aneurism, that if it be the consequence of the obliteration of the superior portion of the artery at a distance from the disease, it is upon the formation of coagulum that the contraction of the sac [redacted] the cure depend.

The deposition of coagulum and the subsequent contraction of the sac, are therefore the circumstances that principally claim our attention, and particularly because in internal aneurisms these are the only means by which the cure can be accomplished. The frequent existence of aneurisms in the thorax and abdomen, and the impossibility of employing

in such cases those operations by which the progress of the disease may be arrested in other situations, render the inquiry of much importance; and numerous instances upon record fully prove that the efforts of art have not unfrequently been availing in impeding the progress, and sometimes allowing nature to effect the cure of the disease. In what manner then can our endeavours be employed for the accomplishment of these desirable objects?

The deposition of the fibrous part of the blood appears to be a general consequence of its being placed out of the course of the circulation; hence in almost all aneurismal sacs this process has taken place, and in those which have long existed it is, I believe, an universal occurrence. But the continual impulse of the circulation within the sac produces such a rapid extenuation of its parietes, that there is much danger that a sufficient deposition of coagulum will not have taken place to resist this force and prevent the rupture of the sac. It is the force therefore with which the circulating blood is sent into the sac that causes its increase and ultimate rupture, at the same time that the rapidity of its motion is adverse to the deposition of its fibrine. How then are we to prevent the increase of the sac whilst the blood that flows into it obliterates its cavity with strata of coagulum?

If it be, as I have stated, the impulse of the circulating blood that causes the enlargement of the

sac and its ultimate rupture, our endeavours should be directed towards diminishing its violence. Indeed it appears, that all which art can with safety effect in the cure of aneurism, is the diminution of the force of the circulation in the sac. The increase of the tumour is thus prevented; the deposition of coagulum forms a strong barrier to its subsequent enlargement, and the gradual contraction of the sac finally causes its obliteration. That a similar process is in most instances the result of the application of a ligature to an artery at some distance from the disease, I shall demonstrate when treating of the operation for aneurism. The force of the circulation in the tumour is merely diminished under such circumstances. The blood conveyed by the anastomosing branches enters the artery above the sac, but in such a diminished stream, that the deposition of coagulum continues until the cavity of the sac is filled, and by its subsequent contraction the disease is removed. The contraction of the sac and the artery seems dependent upon a law in the vascular system, whereby it appears that when the current of blood is obstructed in its passage, or is conveyed in a diminished stream, the vessel gradually contracts in diameter until it corresponds with the current which passes through it, or its cavity is finally obliterated. Thus the same process of obliteration takes place in the umbilical vessels, and the ductus arteriosus soon after birth, as in an artery through which the stream

of blood is obstructed by the application of a ligature.

It remains that we inquire what are the means, independent of obstructing the direct ingress of blood by the application of a ligature to the superior portion of the artery, of diminishing the force of the circulation so as to prevent the increase of the sac, and promote its final obliteration. On this subject it is sufficient to observe, that the general means of diminishing the force of the circulation are repeated blood-lettings, abstinence, attention to diet, perfect quietude, the absence of such states of the mind as peculiarly affect the circulation, and attention to the condition of those organs, more particularly of the alimentary canal, which exert a peculiar influence over the action of the heart and arteries.

Valsalva and Albertini are reported by Morgagni* to have effected the cure of numerous internal as well as external aneurisms by a rigid employment of this debilitating treatment. By repeated blood-lettings and a very meagre diet Valsalva reduced his patients to such an extreme state of debility, that they were scarcely able to raise their arms from the bed. The aneurism diminished in proportion to the debility, and when the disease appeared to be subdued an increase of diet was by

* Letter xvii. art. 30.

degrees allowed. In the following instances I had an opportunity of witnessing the beneficial effects of this treatment.

CASE XXIX.

A SOLDIER, twenty-five years of age, had an aneurism which pointed on the left side of the chest near the sternum in the situation of the fourth and fifth ribs, the cartilages of which were absorbed, and the external tumour was as large as a lemon. The pulsation was extremely violent, and the impediments to respiration were very considerable. Previous to the time when he came into the hospital he led a dissipated life, and the increase of the tumour had been very rapid. He was repeatedly bled, was placed upon a low diet, and took occasional purges. This plan soon reduced him exceedingly; but from that time the tumour ceased to increase, and a lurid inflammation which had taken place upon its apex subsided. In a month the tumour had diminished, and the respiration was much less affected. In three months no external tumour was perceptible; his breathing indeed was difficult, but the inconvenience from this cause was trifling compared with what he had previously endured. Unless he was agitated by passion, or the circulation was accelerated by the use of stimulants, he suffered but little from the disease. In six months he left us and returned to his trade

as a labourer, at which time his breathing was but little impeded. The deficiency of the cartilages of the ribs was very perceptible, but there was no external tumour.

CASE XXX.

A SHORT stout man, about fifty years of age, had an aneurism of the aorta by which the cartilages of the second and third ribs were destroyed. The tumour was as large as a fist, and pulsated violently. It caused great pain and a hacking cough. It had existed six months when I saw him. The pain extended into the abdomen and the neck, his respiration was very difficult when he lay down in bed, and he had frequent palpitations of the heart. The pulse at the wrist was regular. He was bled and purged repeatedly, and a very spare diet was prescribed, with the occasional use of digitalis. Under this treatment the tumour soon became stationary, his respiration less difficult, and in six months he was able to resume his employment as a bricklayer's labourer. The tumour was hard and less elevated than formerly; the integuments which had been inflamed were become firm and healthy. From this time I did not see this patient for three years, when I met with him in an advanced stage of dropsy. His belly and legs were much swollen, and his respiration was very difficult. Upon examining his chest, the aneurism had

entirely subsided, and the part where it had existed was level with the surrounding integuments. The opening in the ribs was distinctly to be felt; he told me that this complaint had afforded him little inconvenience since he left our care unless he was guilty of an excess in diet, and that by abstinence and blood-letting he could always subdue its effects. He died dropsical at the end of a month, but we could not obtain permission to examine the body.

In most of the cases of spontaneous cure which I have related in the former part of this section, this debilitating treatment had been rigidly enacted. In the cases in which the disease originated from the aorta it was carried to a great extent. In Case XX. its beneficial effects were very remarkable; in Case XXII. the patient was repeatedly bled, and reduced almost to the lowest state of existence before the tumour diminished. From the dissection it is evident that the rupture of these sacs could never have taken place, nor would the disease have proved fatal except from the deleterious effects which the tumour exerted upon the organs of respiration. In Case XXX. also the disease was rendered stationary for three years by similar treatment; it was necessary to bleed that man weekly, to prescribe a low diet, with the frequent use of purgatives and digitalis, from which combination he invariably experienced relief when the breathing was more than

usually laborious. This aneurism did not prove fatal by rupture; the sac was fortified with firm and thick layers of coagulum, and the tumour continued to diminish during the last three years of the man's existence*.

It is scarcely necessary to cite authorities to prove the possibility of arresting the progress

* That the diminution of the force of the circulation will prevent the increase of an aneurism, derives additional illustration from the following circumstance. If two sacs exist in the course of the same artery, the obstruction which is caused by the passage of the blood into the upper removes the force of the circulation from the lower, which becomes stationary, or its cavity is obliterated with coagulum. The cure that had commenced in the aneurism of the abdominal aorta in Case XXIII. was probably promoted by the diminution of the force of the circulation by the passage of the blood into the immense sac that was situated in the thorax. In the following instance the progress of the disease appears to have been arrested by a similar occurrence.

CASE XXXI.

About three years before his death, Mr. M. had a violent pulsation at his epigastrium, with all the symptoms of aneurism of the aorta which continued about two years, when a pulsating tumour was observed at the root of the neck above the sternal extremity of the clavicle. The pulsation in the abdomen gradually declined as that at the root of the neck increased, and at length it became imperceptible. In the mean time the tumour in the neck extended rapidly, destroying the clavicles and the upper bone of the sternum. In a few months it had reached to an amazing extent, and

of aneurisms by a practice suggested by Hippocrates*, and confirmed by the experience of Valsalva†, Albertini‡, Morgagni‖, Lancisi§, Guattani¶, Sabatier**, Pelletan††, and Corvisart‡‡. I cannot however avoid expressing my conviction, that if it were rigidly adopted, internal aneurisms would not be regarded as constantly fatal, which opinion has

was the largest aneurism I have ever seen, reaching on the right side as high as the middle of the ear. At length a slough formed on its apex, on the separation of which a fatal hæmorrhage took place. Upon dissection a large aneurismal sac was found to arise from the arch of the aorta, and the whole of the arteria innominata. It contained much coagulum. The ascending aorta was dilated and much altered in structure. The heart was large, but its structure was healthy. The aorta was externally a little enlarged just below the diaphragm; and when it was laid open by a longitudinal incision, a small opening large enough to admit the end of the finger was found to proceed from the posterior part of the artery into a cavity as large as a nut in the body of one of the lumbar vertebræ. This cavity was lined with a smooth membrane, and the edges of the aorta around it were ragged and much diseased.

* *De Morbis*, lib. i. n. 10.

† Morgagni, letter xvii. art. 30, 31. ‡ Ibid.

‖ Ibid. letter xiv. art. 37. xxvi. 10.

§ *De Motu Cordis et Aneurismatibus*, lib. ii. cap. 21. prop. 24, 27, 33.

¶ *De Externis Aneurismatibus*, p. 107.

** *Medecine Operatoire*, tom. i. p. 364.

†† *Clinique Chirurgicale*, tom. i. p. 54.

‡‡ *Essai sur les Maladies du Cœur*, p. 348.

hitherto paralyzed that assistance which art can afford in their treatment. The practice is founded upon reason, and experience has amply proved its importance, but its merits have not hitherto been generally appreciated.

Pelletan* has detailed fourteen cases of aneurism, all of which were materially benefited by this treatment, and in two of them permanent cures appear to have taken place. One man† was sixty-one years of age in whom the aneurism appeared on the right side of the chest. "During the first eight days," says Pelletan, "I prescribed eight bleedings consisting of three porringerfuls (*palettes*) in the morning, and two in the evening. On the fifth day the pain and the pulsation were considerably diminished, but the pulse at the wrist still preserved its fulness. Two porringerfuls of blood were taken from him. The pulse continued weak until the seventh day, when it again rose. Another porringerful of blood was taken from him in the morning, and a second in the evening. During this time the patient was placed upon a rigorous diet. A cold cataplasm, composed of linseed meal and vinegar, was applied to the tumour, and renewed as soon as it became warm. This treatment produced a wonderful effect

* *Clinique Chirurgicale*, tom. i. *Premier Mem. sur les Anevrismes*, p. 54.

† *Observation troisième.*

in eight days. The pain and pulsation disappeared; the debility of the patient did not otherwise injure the state of his health; he observed perfect tranquillity, and did not complain of any uneasiness. When the pain and pulsation had entirely vanished, we gratified his extreme desire to be allowed an increase of diet, but this was done by degrees." When this treatment had been employed twenty-eight days the man left Paris. After some months he returned to his business as a porter, grew fatter than before, and continued without any vestige of the disease except a slight and deep pulsation at the part where the pulsation of the arch of the aorta may be felt in the natural state. Pelletan saw this man daily for two years after the cure was accomplished, when he died of another disease. In a very large axillary aneurism* a cure was effected by similar treatment. The size of the tumour, and the effects which it had produced upon the surrounding parts, placed it beyond the reach of operative surgery. A most abstemious diet, consisting only of two basins of broth during the day, and a common drink of lemonade, was prescribed, and twelve porringerfuls of blood were taken from the arm at six bleedings in the course of the first five days after his admission into the hospital. On the second day after the commencement of this treat-

* *Observation cinquième.*

ment, the tumour was less tense and painful. On the third day it was considerably diminished in size, and evidently consisted of two portions, which were separated from each other by the pectoral muscle. On the ninth day it was one third less in size than at the commencement of the treatment; the pulsation had ceased, but the patient was reduced to an alarming state of debility. He continued in this state two days, and recovered from it by the use of a more generous diet and a little wine. The pulse returned in the opposite wrist, but not in the aneurism. The tumour became softer. Powdered ice enclosed in bags was applied for twenty days, when a solution of salt was substituted for it. The swelling gradually contracted, and in forty-six days the surrounding parts were easily distinguishable. The limb had recovered its strength and motion; there was no pulsation in the tumour nor at the wrist of the affected arm, and his general health was completely restored. Some months afterwards there remained only a small knot in the axilla.

In several instances related by Pelletan, this treatment was not persisted in to a sufficient extent to effect the cure of the disease, but its efficacy in arresting its progress was very apparent. In one patient* the tumour appeared on the right side of the sternum, and was as large as an egg. The

* *Observation quatrième.*

patient was bled eight times during the first seven days of the treatment; ice was applied to the tumour, and a most abstemious diet was prescribed. On the third day the tumour was much diminished in size, and on the fifth did not project beyond the ribs. In fifteen days the patient found himself so well, that he left the hospital. In a second case *, in which the tumour appeared above the right clavicle, six porringerfuls of blood were taken from the patient in one day; and on the following morning the size of the tumour, the pain, and the impediments to respiration, were surprisingly diminished. The patient, however, would not submit to the rigorous treatment that was prescribed, and died some months afterwards, from the pain and impediments to respiration which were produced by the tumour. In a third case †, the disease was situated on the left side opposite to the fourth and fifth ribs. The man was bled twice on the first day; ice was applied to the tumour, and an abstemious diet was enjoined. The following day the tumour was diminished in size; six porringerfuls of blood were taken from his arm at three bleedings; the diet consisted of two basins of broth in twenty-four hours, with lemonade as a common drink, and a lotion of vinegar and water was substituted for the application of ice. On the fourth day the tumour had

* *Observation sixième.* † *Première Observation.*

almost disappeared, and its pulsation was very feeble. A dozen leeches were applied to it, and the same rigorous course of treatment was employed until the eighth day, when the patient insisted upon an increase of diet, which augmented the pulsation of the tumour, and in a few weeks he left the hospital. Upwards of two years afterwards the tumour was considerably enlarged; the skin upon its surface was livid, and perforated by several holes, through which a quantity of bloody serum was forced at each pulsation of the heart. He died however of suffocation, and not of hæmorrhage, on the fifth day after this appearance had taken place on the tumour. Upon dissection, the sac which was situated opposite to the semilunar valves of the aorta was found to contain a firm clot of coagulum. In another instance*, the aneurism appeared below the right clavicle. Ten porringerfuls of blood were taken from this woman on the first and second days after the treatment was commenced; ice was applied to the tumour, and her diet consisted of six cups of chicken broth and two glasses of almond milk in each day. Twelve leeches were applied to the chest on the fourth day, and the same number on the fifth. On the sixteenth day the tumour had disappeared, and only a slight pulsation was perceptible in its situation. By great attention the disease was rendered tranquil

* *Deuxième Observation.*

for more than a year, when the pains in the chest returned, and a pulsation was discovered underneath the left clavicle. By bleeding and the application of leeches these symptoms were mitigated. Some months afterwards, a tumour, as large as a pigeon's egg, appeared on the left side between the third and fourth ribs, and another was discovered immediately below the clavicle. She was twice bled; leeches, and subsequently ice, were applied to the chest, and a very meagre diet was prescribed. The cough and the pains diminished, and in a few days the tumours had disappeared. This patient lived three years after the treatment was commenced, and at length died from the extreme debility induced by the impediments to respiration and a constant diarrhœa. Upon dissection, an immense sac, which nearly filled the left side of the thorax, was found to originate from the arch of the aorta. Its cavity was lined with firm layers of coagulum, and by its pressure upon the left carotid artery it had completely obliterated the cavity of that vessel.

These cases fully prove that the diminution of the force of the circulation by bleeding, quietude, and an abstemious diet, is capable of arresting the progress of internal aneurisms. In addition to the instances which I have already related, I had an opportunity of witnessing the palliative powers of this debilitating treatment in the following case.

CASE XXXII.

A THIN woman, about thirty years of age, fourteen months ago perceived a violent beating in the upper part of the chest, attended with frequent palpitations of the heart and difficult respiration. About ten weeks after the commencement of these symptoms, a pulsating tumour appeared on the right side of the chest, in the situation of the second and third ribs. There was no doubt that the disease was an aneurism of the aorta; and the tumour, with the impediments to respiration and intolerable pain in the chest, increased rapidly. When I saw her, there was a general pulsation at the upper part of the chest, and the external tumour was larger than an egg. There was an appearance of great anxiety in this patient's countenance; the pain was extreme, and her sleep was destroyed by the frequency of the cough and the difficulty of respiration. During the first week of the treatment she was twice bled to a great extent; a cold lotion was applied to the tumour, her diet consisted entirely of currants, barley water, and a little bread, and she was repeatedly purged. The pain and difficulty in breathing were relieved, but the tumour continued to increase. She could not be prevailed upon to persist in the treatment, and left her medical attendants. In a fortnight however she returned to them, and

willingly submitted to that treatment from which she had already experienced relief. The tumour had increased rapidly, and was now as large as a fist. The pulsation was vehement, and elevated the sternum, the cartilages of the ribs, and the clavicles. She was reduced to a great degree of emaciation by the constant pain, the cough, and extreme difficulty in breathing. She was bled largely and repeatedly. In the course of the five following weeks she was bled fourteen times. A pint of blood was generally taken away at each bleeding, and sometimes a larger quantity. Fourteen leeches were applied to the chest at different intervals. Her diet consisted principally of tea, or some mild liquid, and a little bread and butter. Digitalis and squills were given to her, but the derangement which they produced in her stomach and bowels caused them to be discontinued, and occasional purgatives were alone administered. The pain, anxiety, and impediments to respiration, decreased under this treatment. The tumour became harder, and gradually diminished in size. She was unwilling to submit to a continuance of the bleedings, but the inconvenience which she experienced from the slightest exertion or indulgence in diet rendered her very abstemious. It is now more than a year since the treatment was commenced, during which time I have had frequent opportunities of seeing her, and of watching the decrease of the tumour. At pre-

sent it is not larger than a pigeon's egg, and is situated immediately below the right clavicle opposite to the cartilages of the second and third ribs, which are absorbed. The clavicle, sternum, and surrounding parts, are still slightly thrust outwards at each pulsation of the heart. The tumour is firm, the pulsation is deep, and the integuments are healthy. It is diminished in size at least one-fourth during the last year. The impediments to respiration have subsided unless the patient is agitated; she complains only of a weazing cough, which troubles her more particularly when in a recumbent posture. Her general health is good in every respect. She is grown fat and strong, notwithstanding her diet consists principally of bread and butter and tea. Experience has proved to her the painful effects of an indulgence in diet; and when from any cause the pain, the difficulty in breathing, and pulsation in the tumour, are increased, she obtains relief by losing blood.

At the same time that the preceding cases show the efficacy of the debilitating treatment in arresting the progress of aneurisms, they point out the extent to which it must in some instances be carried in order to produce that effect. Pelletan, indeed, urged it to an alarming degree; but it was when the patient was reduced to the utmost state of debility that the greatest benefit appears to have been derived. Valsalva was equally rigor-

ous in his practice. "When Valsalva," says Morgagni*, "had taken away as much blood as was requisite, he made it a custom to diminish the quantity of meat and drink more and more every day, till he came so far as to allow only half a pound of pudding in the morning, and in the evening half that quantity, and nothing else except water, and this also within a certain weight. After he had sufficiently reduced the patient by this method, so that he could by reason of weakness scarcely raise his hand from the bed in which he lay by Valsalva's order from the very beginning of the disease, he increased by degrees every day the quantity of aliment until the necessary strength returned."

The danger of inducing other diseases will in some instances forbid the employment of this debilitating treatment, or at least will prevent its being carried to a sufficient extent to produce permanent benefit. With a view to obviate the probable effects of extreme depletion, it is desirable that the debility which it induces should not be continued longer than is necessary to arrest the immediate increase of the tumour, and that the force of the circulation should subsequently be moderated by great tranquillity and attention to diet. The object of sudden depletion is to prevent the enlarge-

* Letter xvii. art. 30.

ment of the sac; the subsequent deposition of coagulum in its cavity, is a slow and gradual process. In most instances, therefore, it will be sufficient to arrest the progress of the disease by depletion: when this is effected, the danger of inducing other diseases by the continuance of the debility may be obviated by a diet nutritive in its quality, though small in quantity.

It is desirable that the bleeding should not be carried to such an extent as to produce fainting, when the disease is situated in the aorta; for the blood is liable, during that state, to accumulate in the aneurismal sac, and to form an impediment to the circulation when the action of the heart revives. I have known fainting, under such circumstances, continue so long as to excite considerable alarm. Morgagni* mentions an instance in which it terminated in death. The bleedings therefore should be small in quantity and frequently repeated, so as to obviate this effect; for the same reason it is desirable that the blood be taken away in a small stream rather than suddenly and through a large orifice. It probably was with this view that Pelletan† merely opened the vein in one of his patients, and did not apply a ligature to the upper part of the limb, so that the blood was allowed to dribble slowly into a napkin.

* Letter xvii. art. 32.

† *Loc. cit. Deuxième Observation.*

Blood-letting and a meagre diet are the most powerful means of diminishing the force of the circulation, but there are other agents which are capable of promoting that object. The immersion of the extremities in warm water was employed by Valsalva*, with the intention of diminishing the quantity of blood which would otherwise enter the aneurism by diverting it into other parts. The effect of this practice, however, can be only temporary; as such it may probably be employed with advantage during the paroxysms of dyspnœa with which aneurisms of the aorta are sometimes accompanied.

Digitalis has also been recommended as a powerful agent in diminishing the action of the heart and arteries. With this view I have seen it employed in the treatment of aneurisms, and in some instances with apparent benefit, more especially when the disease was accompanied, as is frequently the case, with dropsical effusions. Most writers have recommended the mineral acids as a common drink, but I am not acquainted with the principle upon which they can be expected to promote the cure of aneurisms. It is probable, however, that some peculiar articles of diet may contribute more than others to promote the formation of coagulum; but, on this subject, experience has not hitherto furnished any decisive indications.

* Morgagni.

The application of powdered ice, or of water in which ice is dissolved, has been recommended in the treatment of aneurisms, either with the intention of coagulating the contents of the sac, or of promoting its contraction. M. Guerin* has strongly advocated its employment, and Pelletan used it in several instances, in which he effected considerable benefit in internal aneurisms. I have seen it applied to a large inguinal aneurism, but it produced such excruciating pain that its employment was from necessity discontinued. Pelletan, in most instances, also applied leeches to the tumour; their effect can be merely that of diminishing the force of the circulation by the abstraction of blood. When the integuments are thin and livid, the application of leeches will tend to accelerate the formation of the slough which precedes the rupture of the tumour.

From the preceding observations, I think I am warranted in the following deductions.

First: The deposition of coagulum in the cavity of the aneurismal sac and the artery leading into it, is the mode by which the spontaneous cure of aneurisms is, in most instances, effected.

Secondly: The coagulum is subsequently absorbed, and the sac and the artery contract until the one becomes an impervious cylinder, and the other a small fleshy tumour.

* *Recueil periodique de la Societé de Santé à Paris*, n. iii.

Thirdly: In some instances the cure is effected by the obliteration of the cavity of the sac without any obstruction taking place in the calibre of the artery from which the disease originates; in this manner a cure may take place in aneurisms of the aorta.

Fourthly: The formation of coagulum being a general occurrence in aneurisms, it is an important object to prevent the increase of the sac, that the deposition of coagulum may proceed to such an extent as to obliterate its cavity.

Lastly: It is the force of the circulation which causes the enlargement of the sac and its ultimate rupture; hence the diminution of the force of the circulation is the princi, al indication in promoting the spontaneous cure of aneurisms.

SECTION IV.

ON THE SURGICAL TREATMENT OF ANEURISM, AND ON COLLATERAL CIRCULATION.

THE surgical treatment of aneurism consists in the obliteration of the cavity of the artery communicating with the sac, so that the ingress of the blood into the latter is either entirely prevented, or the stream which passes through it is supplied only by anastomosing branches, and consequently the force of the circulation is so much diminished, that the increase of the tumour is prevented, and the deposition of coagulum is promoted. By the absorption of its contents, and the gradual contraction of the sac, the cure is ultimately accomplished. The blood is conveyed to the parts which it is destined to supply by collateral vessels, some of which, being gradually enlarged, constitute permanent channels for the circulation. The obliteration of the artery is effected by the excitement of such a degree of inflammation in its coats as shall produce adhesion of its sides. These objects have been attempted by the compression, or by the ligature of the artery. The latter method constitutes the operation for aneurism.

Compression has long been employed in the treatment of aneurism, and cases are recorded in

which it is said to have effected the cure of the disease. The merits of the practice, however, appear to have been greatly overrated: the cures which took place during its employment were probably effected by the other means with which it was combined, rather than by the compression of the tumour or the artery. Most of these cases appear to have undergone spontaneous cures, which were promoted by the rigid courses of depletion, abstinence, and quietude, which were combined with the employment of compression. The failure which so frequently attended the old operation for aneurism, and the danger with which it was always accompanied, rendered the discovery of a more successful and less perilous mode of treating the disease an object of great importance. Until therefore the advantages of the modern operation for aneurism were ascertained by experience, compression was strongly advocated by systematic writers. The improvements that have now taken place in this branch of surgery render the cure of aneurisms by the ligature of the superior part of the artery infinitely preferable to the tedious and uncertain practice of compression; and an examination of the success that has attended its employment and the principles of its operation, will prove that it cannot be relied upon for the cure of this disease.

Two modes of applying compression have been

recommended for the cure of aneurism. First, the compression of the whole limb in which the disease is situated; and secondly, the compression of the superior portion of the artery at a distance from the disease.

Guattani, who strongly advocated the treatment of external aneurisms by compression, has related cases which were cured during its employment. His practice consisted in the application of compresses to the tumour and the upper part of the artery, which were firmly bound down by a circular bandage, with which the limb was rolled from the seat of the disease to the groin*. Two compresses were applied to the tumour in a crucial direction, and a third was placed in the course of the femoral artery. The whole of the upper part of the limb was then surrounded by a common roller, commencing upon the tumour, which was firmly and equally compressed. The bandage was continued below the knee and up the limb, being retained to the superior part of the thigh by a few turns round the body. The applications were moistened with an astringent lotion, and at each renewal of the bandage the degree of pressure was increased. The patient was repeatedly bled, and a most abstemious diet, with perfect quietude, was observed during the treatment. Although Guattani employed this prac-

* *De Externis Aneurismatibus*, p. 26.

tice in several cases, his success was comparatively trifling. He relates fourteen instances in which it was adopted. In seven of them no benefit was obtained; in one the tumour was considerably diminished, but the termination of the case is not mentioned: in a second, although compression was employed with apparent benefit for three years, the tumour ultimately increased, and required an operation: in a third, the pain which it produced was so excessive, that the bandage was from necessity discontinued, and in only four cases the disease was cured during its employment. In these instances, extreme abstinence, quietude, and blood-lettings, were employed to such an extent, and during so great a length of time, as to render it probable, that had not compression been combined with these means, spontaneous cures would have taken place*.

* The following abstract exhibits the nature of the cases in which Guattani employed compression, the length of time during which it was continued, and the rigid courses of abstinence and depletion with which it was combined in those instances in which cures were effected.

Hist. vi. The tumour in the ham was as large as a goose's egg. It was hard to the touch, pulsated violently, and was attended with œdema, pain, and fever. The patient was confined to his bed, repeatedly bled, and used a slender diet. The increase of the tumour was by these means arrested; and in the following month the pain, pulsation, and œdema of the limb, were diminished. At the commencement of the third month after the employment of this treatment, at which time there

It is difficult to conceive upon what principle this mode of applying compression can effect the

remained but little pain and swelling of the limb, compression was employed in the manner which I have above described. The patient was repeatedly bled, and the same course of quietude and meagre diet was observed. The tumour daily diminished, and at the end of three months from the commencement of the compression there remained only a knot in the ham as large as a chesnut.

Hist. vii. In this case the tumour was larger than in the preceding instance, and was attended with acute pain, fever, and swelling of the limb. During the first eight days after his admission into the hospital, which was in the month of August, the patient was twice bled, confined to his bed, and used a slender diet. After the application of an astringent lotion for some days, compression was commenced. In the beginning of November the pulsation had entirely ceased, and the contents of the tumour appeared to have become fluid. The treatment was continued until January, when the man left the hospital, and experienced no inconvenience from the disease, except a slight lameness.

Hist. viii. This case was similar to the preceding, and similar treatment was successfully employed. In forty days the hardness and pulsation had disappeared, and nothing was left but a tumour containing a fluid, which was gradually absorbed. Some weeks afterwards the patient was entirely free from the disease, and there remained only a swelling of the leg, which Guattani imputed to a want of sufficient rest during the cure.

Hist. ix. This patient was seen by Guattani three months after the commencement of the compression under the direction of two surgeons at Rome. The cure of the aneurism was com-

cure of aneurisms, and the inconveniences with

plete, and nothing remained but a distention of the integuments, for which the compression was continued.

Hist. x. This was a case of popliteal aneurism which had been under the care of a surgeon who imputed Guattani's success to the quietude which was combined with the employment of compression. The patient had been confined to his bed five months before he came to Guattani, without any advantage, except that the tumour ceased to increase during that time. Sixteen months after the commencement of the disease, the aneurism had acquired an immense size, extending to the middle of the thigh and down the leg. The patient was repeatedly bled, adhered to a slender diet, and compression was applied as in the former instances. The tumour diminished, but the patient would not submit to the treatment, and was dismissed from the hospital in the tenth month after his admission. At that time the tumour, though hard and possessing a strong pulsation, was not larger than two thumbs.

Hist. xi. In this case the aneurism was small. The patient would not submit to the treatment, and in a short time died of gangrene of the limb.

Hist. xii. This was a large popliteal aneurism, attended with extreme pain, pulsation, and œdema. After repeated bleedings, moderate pressure was applied, but the danger of gangrene caused it to be discontinued, and the patient died in consequence of the rupture of the tumour.

Hist. xiv. In a large inguinal aneurism compression was employed for three years. The tumour diminished considerably, and the patient was enabled to discharge the duties of a coachman. At length, however, the disease increased, and an operation was performed which proved fatal.

Hist. xvi. This was a large inguinal aneurism, in which the tumour, pain, and fever, were at first diminished by bleed-

which it is attended are very considerable. Scarpa* imagines, that the pressure, by placing the two opposite parietes of the injured artery at the mouth of the aneurismal sac in firm and complete contact, and at the same time exciting the adhesive inflammation in its coats, produces obliteration of the cavity of the vessel. If this be the mode by which pressure effects the cure of aneurism, the cases in which it is applicable are very rare. In almost all

ings and compression. After a month, however, the pain was so extreme, that the bandage could not be endured; the tumour increased rapidly, and proved fatal by bursting into the abdomen.

Hist. xx. The tumour in this instance was as large as an egg, and was situated in the upper part of the leg, near the ham. The patient was bled, confined to his bed, and used a slender diet for several days, when the limb was rolled from the middle of the leg to the groin. The pain however was so great, that although the patient was again bled, the bandage was obliged to be loosened. In a few days it was again applied, but the pain and swelling of the limb returned, and the patient was compelled to obtain relief by removing the bandages. Compression was tried a third time, but again discontinued, on account of the insupportable pain which it produced. The patient ultimately died of fever.

Guattani mentions having tried compression in four cases of aneurism, situated in the upper part of the leg, without success. In one instance, (Hist. xix.) after a long time, the patient died of the suppuration of the tumour.—*See* GUATTANI *De Externis Aneurismatibus.*

* *Treatise on Aneurism*, WISHART's *Translation*, p. 203.

aneurismal sacs, even in a very early stage of the disease, a sufficient deposition of coagulum will have taken place, to prevent the possibility of placing the opposite sides of the artery at the mouth of the aneurism in a state of complete contact; and when the tumour is large, and attended with much fever, pain, and swelling of the limb, it is very evident that such a degree of pressure as shall effect this object will be insupportable. One of the objections also, which have been urged to the old operation of tying the artery at the mouth of the sac, is applicable to compression, even in most cases where it would be possible to place the sides of the vessel in contact. The diseased condition of the artery in this situation, renders it probable that the inflammation excited in its coats by pressure, would be productive of the suppurative, instead of the adhesive, inflammation. It was with the intention of producing the suppuration of the whole tumour, that Guattani* employed compression in several instances. Circular bandages, by obstructing the venous and lymphatic circulations, will very much augment the œdema and pain; by compressing also the arteries on the opposite side of the limb, they impede the establishment of a collateral circulation. It is however possible, that this mode of applying

* *De Externis Aneurismatibus*, p. 74.

compression, by diminishing the calibre of the artery, may lessen the impulse of the circulation in the aneurismal sac, and promote the absorption of coagulum. In Guattani's cases, even where the pulsation still continued, the tumours diminished during its employment; and I have in several instances witnessed its effects in promoting the absorption of coagulum after the operation for aneurism. In a few rare instances in which the body of the tumour is reflected upon the superior part of the artery, it is possible that the application of a bandage, by compressing the artery between the tumour and the bone, may promote the obliteration of its cavity, and in that manner effect the cure of the disease*. Moderate compression therefore may be advantageously combined with the debilitating treatment, to promote a spontaneous cure; but the cases in which it is possible to place the sides of the artery at the mouth of the sac in contact, are so rare, and the degree of pressure which is requisite to ensure their adhesion is attended with such inconveniences, and so slight a prospect of success, as to render this practice unworthy of confidence as an immediate agent in the cure of aneurism†.

* See Case xviii. p. 107.

† The following is Scarpa's opinion as to the cases in which it is proper to employ compression:—"The compression is

The compression of a portion of the artery above the disease, has also been recommended in the treatment of aneurisms in the extremities. The object of this practice is to place the opposite sides of the artery in a state of contact, and at the same time to excite such a degree of inflammation in its coats as shall produce their adhesion. When this is effected, the disease will be placed in the same condition as after the modern operation for aneurism, in which the cavity of the artery is obliterated at a distance from the tumour, by the application of a ligature. The absorbents will remove the coagulum which is deposited in the sac, and the circulation through the limb will be carried on by collateral vessels.

contraindicated whenever the popliteal aneurism is spontaneous, or not depending upon a wound or extraordinary violent stretching of the artery; when the popliteal aneurism is of long standing and of prodigious size; when it is very hard; when it occasions acute pain and sympathetic fever; when it has produced considerable swelling of the leg and foot, with a diminution of their heat; and when the aneurismal sac is situated too high or too low in the ham. On the contrary, the surgeon's hope of a cure being obtained by compression will be well founded in every case where the popliteal aneurism is very small, recent, and produced by a violent stretching of the artery; when it is indolent, soft, and yields to the pressure of the hand; when it is situated exactly in the middle of the cavity of the ham; and when it is not accompanied by swelling or numbness of the leg or foot."—*Treatise on Aneurism*, WISHART'S *Translation*, p. 230.

Various mechanical contrivances have been recommended, for the purpose of compressing an artery without constricting the limb, and obstructing the passage of the blood through the collateral vessels. Local compression has long been employed in the treatment of wounded arteries, and systems of surgery abound in the descriptions of instruments for the purpose of effecting this object. Mr. Freer ascertained that the pressure of a tourniquet upon the radial artery of horses, in the course of four days produced a deposition of "coagulable lymph, not in the cavity of the vessel, but surrounding it, and effused into the coats of the artery, whose tube was so much contracted and pressed together, as to render it completely impervious to the passage of blood*." The result of Mr. Freer's experiments was the same as when large blood vessels are obliterated by the pressure of tumours, and this mode of employing compression was accordingly proposed, as a practice by which the cavity of an artery might be obliterated, and the cure of aneurism effected. Experience however proves that the pain is insupportable which is produced by screwing the instrument to that degree of tightness which is required to effect the obliteration of the artery. In the temporary application of the tourniquet during amputation it is universally a source of great distress to the patient; from this circumstance it may

* *Observations on Aneurism*, p. 14.

be imagined, what must be the protracted suffering which is necessary for the excitement of inflammation in a deep-seated artery. This practice was tried in a case of popliteal aneurism, under the care of Sir William Blizzard, by means of an instrument, the points of support for which were "the outer part of the knee and the great trochanter, a piece of steel passing from the one to the other; and to the middle of this a semicircular piece of iron was fixed, which projected over the femoral artery, having a pad at its end moved by a screw, by turning which the artery was readily compressed and the pulsation in the aneurism stopped, without any interruption to the circulation in the smaller vessels. But, although this patient possessed unusual fortitude of mind and indifference to pain, he was incapable of supporting the pressure of the instrument longer than nine hours; and when it was loosened, the pulsation in the tumour returned with unabated force*." In the only instance in which I have known it employed, the patient insisted upon the removal of the instrument in less than an hour after its application. The pain which was produced by continued pressure, was insupportable†.

* *Medical and Physical Journal*, vol. viii. p. 2.

† I am informed, by a most intelligent friend, that in a case of popliteal aneurism, in which he witnessed this practice, it could not be supported longer than two

Richerand* relates a case which was cured during this treatment; but in that instance the compression was gradually applied, and during a year the patient observed perfect quietude, was repeatedly bled, and used a most abstemious diet. Dubois† is also said to have been successful

hours. The compression of the femoral artery was effected by means of a tourniquet. A broad piece of wood was placed upon the opposite side of the limb, so as in some degree to prevent the constriction of the collateral vessels. In another instance, in which it was applied to the brachial artery, the pain and swelling of the limb were so considerable on the following day, that the surgeon was compelled to abandon this practice.—Mr. Hunter attempted to obliterate the cavity of a femoral artery by pressure, in a case of popliteal aneurism, but the patient could not support its employment.—See *Transactions of a Society for the Improvment of Medical and Chirurgical Knowledge*, vol. i. p. 160.

* "A grocer was recently cured of a popliteal aneurism, by confining himself for a year to a state of absolute quietude, keeping his bed, using a slender diet, losing blood every month, and compressing the crural artery upon the femur where it passes behind the adductor muscle. The compression was effected by means of a semicircle of elastic steel, similar to a truss; a screw, to the end of which a pad was affixed, served to regulate the pressure upon the vessel. The pain at first rendered him unable to continue the pressure, but by accustoming himself to it by degrees, and gradually increasing its force, the pulsation diminished, and afterwards entirely ceased. The tumour subsided, became harder, and was reduced to a small tubercle."—*Dictionnaire des Sciences Médicales, Art. Anévrysme.*

† Ibid.

in several instances in which he employed this practice.

The most distressing symptoms that attend internal aneurisms, are produced by the pressure of the tumour upon the important organs that are situated in its vicinity. But these effects are generally mitigated when the bones are destroyed, and the tumour projects externally. All attempts therefore to repress the growth of aneurisms proceeding from the thorax or abdomen by external pressure, are injurious, and attended with an aggravation of the symptoms. The projection of the tumour may sometimes be prevented by pressure, but its expansion internally, and its effects upon the surrounding parts, will be promoted by this treatment. The ancient practice therefore of confining aneurisms that project from the thorax or abdomen by plates of lead, compresses and bandages, is very injurious, and sometimes productive of the most serious consequences. Lancisi* relates the history of an aneurism of the aorta, in which the rupture of the sac into the lungs was the effect of external pressure. When the integuments however are upon the point of giving way, or sloughing has commenced, the application of compresses, adhesive straps, and bandages, by restraining the hæmorrhage, will tend to prolong a wretched existence.

* *De Motu Cordis et Aneurismatibus*, p. 248.

The cure of aneurisms by compressing the artery has to some appeared so plausible, that it has been attempted even on the denuded vessel, with the intention of placing its opposite sides in contact, and exciting such a degree of inflammation in its coats as shall effect their adhesion. Guattani* having laid open a large aneurism in the groin and removed its contents, applied graduated compresses to the extremity of the artery at the mouth of the sac, and retained them firmly in that situation by a bandage. On the thirteenth day the dressings were removed. There was no discharge of blood, and the mouth of the artery was closed. The cavity suppurated, and the patient recovered. This mode of obliterating the cavity of arteries has also been employed by Trew†, Teichmeyer‡, Heister‖, and several other surgeons. It is evident, however, that the danger of hæmorrhage, independent of many other circumstances, renders this mode of treatment greatly inferior to the more certain operation of a ligature.

The operation for aneurism was confined to those cases in which the disease is produced by a

* *De Externis Aneurismatibus*, Hist. xv. p. 50.

† *Aneurismatis Spurii Hist. et Curatio.* LAUTH. *Collect. Script. de Aneurismat.* p. 549.

‡ *Ibid.* LAUTH. *Collect.* p. 552.

‖ HALLER *Disputat. Chirurgicæ*, tom. v. p. 131. — See also SCARPA *on Aneurism*, WISHART's *Translation*, p. 209.

wound of the brachial artery in the operation of bleeding, until about the year 1646. At that time Severinus published a case in which he and Trullus cured an aneurism in the thigh by cutting open the sac and tying both ends of the wounded femoral artery*. More than forty years afterwards a similar operation was successfully performed by M. Bottentuit, surgeon to the Hotel Dieu†. Notwithstanding these cases, and some others upon record, in which the cavity of the vessel was obliterated in the spontaneous cure of aneurisms, the fear of gangrene, in consequence of a deficient supply of blood, deterred surgeons from the ligature of the principal arteries of the lower extremity. It was not until the middle of the last century, when Haller and Winslow had demonstrated the collateral vessels by which the circulation might be carried on, that the operation was repeated upon the femoral and popliteal arteries by Guattani, Mollinelli, Teislere, Mazotti, and several Italian surgeons‡. The first instance upon record in which the femoral artery was tied in this country, occurred to Mr. Burchall at the Manchester Infirmary in the year 1757||. Pelletan asserts, that he

* Severinus *de Efficaci Medicina*, cap. 3.

† Saviard's *Cases in Surgery*, Obs. lxiii. p. 141.

‡ See Pelletan, *Clinique Chirurgicale*, tom. i. p. 116.

|| *Medical Observations and Inquiries*, vol. iii. p. 106.

was the first who tied the popliteal artery in France, in the year 1780*; about that time the operation became frequent both in this country and upon the continent.

Until the year 1785, when Mr. Hunter first performed the modern operation, the treatment of external aneurisms consisted in cutting open the tumour, cleansing it of its contents, and tying both ends of the artery at each extremity of the sac. The cavity was then filled with lint and various medicines: a dreadful suppuration was induced, and in a few instances the sore granulated, and the patient recovered. The difficulties which occurred in the performance of this operation were very distressing. The depth at which the artery was situated in the ham, and the firm adhesions which it had acquired to the surrounding parts, rendered its detachment in most instances extremely difficult: the operator was either compelled to dissect it for some distance beyond the tumour, or to pass the ligature by means of a common needle, and tie the vein, nerve, and surrounding parts together with the artery. During the operation, the surgeon was embarrassed by a constant flow of blood from the smaller arteries which opened into the sac, or from the lower extremity of the vessel, and it rarely happened that until the hæmorrhage was

* See PELLETAN, *Clinique Chirurgicale*, tom. i. p. 116.

suspended by the occurrence of fainting, that the situation of the injured artery could be ascertained. When the patient had recovered from the immediate effects of the operation, he had still great dangers to encounter. The coats of an artery at the mouth of an aneurismal sac are generally in such a diseased condition, that there is great danger that the inflammation excited in them by the ligature, instead of producing the adhesion of the sides of the vessel, and the consequent obliteration of its cavity, will terminate in ulceration or gangrene. In this case, upon the separation of the ligature, the mouth of the artery will be pervious, and a fatal hæmorrhage will probably ensue. From the mode of dressing the sac, and the nature of the parts of which it was composed, a tedious suppuration or sloughing was sure to take place. Sometimes the sloughing or suppuration proceeded to such a degree as to extend beyond the point at which the ligature was applied to the artery. This constituted another cause of secondary hæmorrhage; and even when the ligatures had separated favourably, the patient was fortunate if he recovered from the tedious suppurations and sloughings which took place in parts so deeply situated, and which generally involved the surrounding vessels, tendons, and ligaments, and frequently produced caries of the bones. Rarely indeed did these patients recover without

a stiff or contracted joint, or the total loss of power in the limb. Deschamps has accurately described the difficulties which he met with in the performance of this operation in the ham, and the dangers which attended the subsequent condition of the parts. "The operation for aneurism," says Deschamps*, "by the incision of the sac, requires a wound through the integuments six or seven inches in length. The cellular membrane situated between the muscles is then to be cut through, sometimes to the depth of three inches, care being taken to avoid the crural nerve. The small arteries that are distributed to the muscles are liable to be divided in this stage of the operation, and it is necessary to secure them. The sac being opened, the coagulum and blood that it contains is to be removed. It is frequently necessary to wash, cleanse, and in a manner to rub off the coagulum from the whole surface of this enormous cavity, either with lint or a sponge. The assistants are compelled to pull asunder the sides of the wound, that the operator may be enabled to see the bottom of the cyst. The cavity being cleansed, the opening in the artery is to be discovered; but this is not so troublesome a part of the operation as the application of the ligatures at so great a depth.

* *Observations sur la Ligature des Artères Blessées, et sur l'Anévrisme de l'Artère Poplitée*, p. 75.

If any collateral branches open into the artery between the two ligatures, since it is uncertain from what point the blood proceeds, it is necessary to compress the opening in the vessel, or to apply astringents or caustics. A tedious operation, producing extreme pain and irritation to the patient; an inflammatory swelling of the parts, proportioned to the extent of the disease; sloughings and suppurations, arising from the exposure of so large a surface; collections of matter dependant upon the depth of the cavity, and the approximation of the sides of the wound; sinuses which it is difficult to heal; swellings, and abscesses; and lastly, in some instances a cure, rendered tedious by the destruction of the flexor tendons, so that the utility of the limb is destroyed, are the general consequences of this mode of operating." Nothing can be more horrible than the histories of this operation recorded by Guattani*, Masotti†, Deschamps‡, and Pelletan‖, all of whom acknowledge the difficulties and dangers which I have described. The frequency of its failure, and the dreadful sufferings with which it was at all times accompanied, induced many surgeons of the great-

* *De Externis Aneurismatibus*, hist. i. p. 2.

† *Dissert. sull' Aneurysma*, p. 24.

‡ *Observations sur la Ligature des Artères*, &c.

‖ *Clinique Chirurgicale*, tom. i. *Mémoire sur les Anévrismes Externes.*

est experience, among whom it is sufficient to mention Pott*, and Deschamps†, to declare, that until a better mode of treating the disease was discovered, amputation was the only resource in popliteal aneurism.

Such was the state of surgery with regard to the treatment of external aneurisms when Mr. Hunter proposed and performed the modern operation in the year 1785. His active mind, guided by a deep insight into the powers of the animal economy, substituted for a dangerous and unscientific operation, an improvement founded upon a knowledge of those laws which influence the circulating fluids and absorbent system, and few of his brilliant discoveries have contributed more essentially to the benefit of mankind. He was convinced that simply taking off the force of the circulation from the aneurism was sufficient to effect a cure of the disease, or at least to put a stop to its progress, and leave the parts in a situation from which the actions of the animal economy are capable of restoring them to a healthy state. With this view he tied the artery at a distance from the aneurismal sac, whereby the influx of the blood into the latter is either entirely prevented, or being conveyed only by anastomosing branches,

* *Chirurgical Works*, vol. iii. p. 220. Sir James Earle's edit.

† *Observations sur la Ligature des Artères*, &c. p. 63.

it enters the tumour in so small a stream, and with such diminished impetus, that the increase of the disease is prevented, and the deposition of coagulum is promoted. The coagulum is subsequently absorbed, and the sac and the artery contract, until the one becomes an impervious cylinder, and the other a small fleshy tumour.

The advantages of this practice, when contrasted with the ancient operation, are most important. The surgeon is in most instances enabled to fix upon a portion of the artery for his operation, where it is situated near the surface of the body, and is free from collateral branches. During its performance, he is not embarrassed by the flow of blood from surrounding vessels, and he is enabled with facility to detach the trunk from its natural connexions. At a distance from the disease the coats of the artery are less liable to be affected with those morbid changes which have generally been found in them near an aneurism. Secondary hæmorrhage at the time of the separation of the ligature is therefore not so likely to happen in consequence of the want of union in the sides of the vessel, or the occurrence of ulceration in its coats. The cavity of the tumour not being exposed, the tedious processes of sloughing and suppuration are avoided, and hæmorrhage, from these causes, and from the vessels which sometimes open into the sac, cannot occur. The forma-

tion of sinuses and fistulæ, disease in the bones and ligaments, with ultimate lameness and loss of power in the limb, which generally succeed the old operation, are by this mode of treatment avoided. The superiority of the modern operation is now confirmed by experience so general, and reasons so obvious, that it is unnecessary to adduce arguments in favour of its employment.

Although the merit is unquestionably due to Mr. John Hunter of having first pointed out the principles by which the cure of aneurism is effected after the ligature of the artery at a distance from the disease, and of having established the success of the practice by several cases in which he cured popliteal aneurisms by the ligature of the femoral artery, still it cannot be denied that the ligature of the artery above the tumour had been recommended and practised by several surgeons both in ancient and modern times. The Greek and Arabian physicians, more especially Ætius*, and Paulus of Ægina†, distinctly recommended the ligature of the brachial artery a few fingers' breadth below the axilla for the cure of aneurism at the bend of the arm. Guillemeau‡, the cotemporary of Paré, about the year 1590 published the

* Tetr. iv. serm. iii. cap. 10.

† *De Re Medica*, lib. iv. cap. 37.

‡ *Œuvres de Chirurgie*, chap. vi. p. 698.

account of an aneurism at the bend of the arm, which he cured by the ligature of the artery above the tumour; and more than fifty years afterwards Thevenin* recommended and accurately described the same operation. These surgeons, however, after having tied the artery, invariably opened the aneurismal sac and removed its contents, so that they lost one of the principal advantages of Mr. Hunter's operation, in which the removal of the coagulum is left to the absorbents, and the dangerous processes of sloughing and suppuration which attend the incision of the sac are avoided. The treatment of a case by Anel†, which occurred in the year 1710, approached still nearer to the modern operation. Anel tied the brachial artery close to an aneurism at the bend of the arm, but did not open the sac. The pulsation immediately ceased, and the tumour gradually diminished. At length it entirely disappeared, and the patient recovered the use of the limb. Bichat‡ and Richerand‖ assert that Desault tied the femoral artery for a popliteal aneurism, in the same year in which Mr. Hunter performed his first operation. The tumour diminished, and the pulsation ceased. On the

* *Œuvres*, chap. xxxviii. p. 55.

† *Suite de la Nouvelle Méthode de guérir les Fistules Lacrymales*, p. 251.

‡ *Œuvres Chirurgicales* de DESAULT, par Bichat, tom. ii. p. 568.

‖ *Nosographie Chirurgicale*, tom. iv. p. 99.

twentieth day the sac burst, and discharged a quantity of coagulum and pus. At length the sore healed, after the formation of several fistulæ*. The facts which I have now related do not detract from Mr. Hunter's claim to originality, since even in Anel's and Desault's cases the vessel was tied as close as possible to the sac, and these surgeons do not appear to have been acquainted with the great advantages which may be obtained by the ligature of the artery at a distance from the disease. The merit of the discovery consists in establishing the principles by which the operation effects the cure of the disease; in confirming its success by experience, and thereby introducing it to general employment. These objects were unquestionably effected by the genius and exertions of Mr. Hunter.

The success which attended the first cases in which Mr. Hunter performed this operation, caused it in a short time to be repeated by most of the surgeons of eminence both in this country and upon the continent. The superiority of the practice was so evident, that it was adopted by those who had declared that amputation of the limb was preferable to the old operation of

* Deschamps says, that in the first case in which Desault performed this operation, the sac burst shortly afterwards, and the patient was destroyed by the ulceration and caries of the tibia which ensued.—*Obs. sur la Ligature des Artères*, &c. p. 39.

opening the sac*. During the life of Mr. Hunter it was confined to the ligature of the femoral artery, for the cure of popliteal and femoral aneurisms†. Since that time several surgeons in this country, particularly Mr. Abernethy and Mr. Astley Cooper, have extended the principle of this operation to almost every situation of external aneurism; and the improvements that have now been effected in the mode of applying the ligature to arteries have brought the surgical treatment of aneurism to a degree of perfection which leaves but little room for advancement.

There are three points connected with the operation for aneurism which claim particular attention: First, the application of the ligature: Secondly, the mode by which the blood is conveyed through collateral channels to the parts which it is destined to supply: and, Thirdly, the changes which take place in the tumour in consequence

* This mode of operating was adopted by Mr. Pott in a case of popliteal aneurism, before the publication of Mr. Hunter's Cases. See *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 172. Deschamps also employed it in several instances. See *Observations sur la Ligature des Artères Blessées, et sur l'Anévrisme de l'Artère Poplitée*, p. 41, &c.

† An account of Mr. Hunter's Cases was published by Sir Everard Home in the first volume of the *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, p. 138.

of the ligature of the artery at a distance from the disease. I shall consider these subjects in the order in which they are here enumerated.

First: The application of the ligature to arteries after amputation may be said to be a practice of modern date, when compared with its employment in the cure of aneurism. In remote ages, when neither the functions of arteries nor the pathology of aneurism had been investigated, the ligature was employed for the cure of this disease*; and it is remarkable that it was used in those times in a manner which modern experience has decided to be the mode best calculated to insure its success. The vague and false notions which were for centuries entertained relative to the physiology of the vascular system, influenced this department of practice; and the boldness with which the Greek and Arabian physicians recommended the employment of the ligature for the cure of aneurisms, gave way to less scientific and more dangerous refinements of practice. A knowledge of the actual processes employed by nature in the obliteration of an artery upon which a ligature has been applied, was

* Galen, Celsus, Ætius, Paulus of Ægina, Albucasis, and several of the ancient writers, recommended the employment of the ligature in cases of aneurism and wounded arteries. It was not however until the time of Parè that it was used in amputation.

obscured by theories which led to the most disastrous practices. It is at this time generally believed upon the continent, and until very lately it was the received opinion in this country, that the operation of a ligature is confined merely to the approximation of the two sides of the artery, and that the obliteration of the cavity of the vessel is the consequence of their adhesion*. This doctrine led to a variety of inventions, for the purpose of placing a considerable extent of the opposite sides of an artery in contact,—a practice which an investigation of the subject will show to be in direct opposition to the salutary operation of the ligature.

Instead of simply producing an approximation of the opposite sides of the vessel, it has now been ascertained by an extensive series of experiments, that the application of a ligature to an artery is the performance of a distinct operation upon it, producing a wound in its internal and middle coats, which gives rise to an effusion of lymph, whereby the opposite surfaces of the extremity of the vessel

* Léveillé and Richerand, in works published in the year 1812, explain the operation of the ligature upon this principle. See LEVEILLE, *Nouvelle Doctrine Chirurgicale*, tom. iv. p. 243, and *Dictionnaire des Sciences Médicales, Art. Anévrisme*, by RICHERAND. Scarpa also published the same doctrine: *Treatise on Aneurism*, WISHART'S *Translation*, p. 210.

are united, in the same manner as soft parts in general are healed by the adhesive inflammation. The immediate effect of the ligature is the obstruction which it affords to the passage of the blood through the vessel; but its more important results are the adhesion and obliteration of the extremity of the tube. The processes by which these objects are accomplished are the following*. The internal and middle coats are cut through by the ligature, and are thus placed in the condition of simple incised wounds†. From these cut edges an effusion of lymph takes place, which seals the extremity of the tube, forming a matrix for vessels which extend from the wounded surfaces, and unite the opposite sides of the canal in that situation. At the same time the inflammation excited in the coats of the artery produces an effusion of lymph between them with which they are thickened, and from the surrounding parts a similar

* We are indebted to Dr. Jones for a most elaborate and scientific investigation of this subject by experiment. See *A Treatise on the Process employed by Nature in Suppressing the Hæmorrhage from Divided and Punctured Arteries; and on the Use of the Ligature:* by J. F. D. Jones, M. D.

† This fact was first noticed by Desault, and communicated to Dr. Jones by Dr. John Thompson. See Jones *on Hæmorrhage*, p. 126. It is mentioned also by Bichat, *Anatomie Générale*, tom. ii. p. 281.

effusion takes place, which covers the vessel externally, and affords it additional support. The ligature causes the death of that portion of the external coat with which it is in immediate contact. In a little time this slough is detached by ulceration, and the ligature is cast off. But the recent adhesion at the extremity of the vessel would probably be too weak a barrier to the impulse of the circulation, especially in the larger arteries, if the portion of the vessel between the ligature and next collateral branch were not, in most instances, filled with the coagulum of the blood, which in this situation meets with an obstacle to its progress, and is placed as it were out of the course of the circulation. The coagulum deposited from the blood under these circumstances forms a plug, which removes the impulse of the circulation from the recently cicatrized surfaces. This plug, however, serves but for temporary purposes. It is gradually absorbed; and that portion of the vessel which is situated between the ligature and the next collateral branch contracts, and ultimately degenerates into a simple ligamentous cord.

Such are the processes which Dr. Jones ascertained to follow the application of a ligature to an artery, differing from his account of them only in this point, that the ligature is here stated to cause the sloughing, and not the ulceration of that

portion of the external coat which it immediately embraces. This circumstance I have inferred, from the examination of several arteries which have been tied in the human subject as well as in brutes; and from having observed that, after several operations for aneurism, in which the vessel was not divided, the ligature brought with it, in its ring, a considerable portion of slough of a cellular structure, accurately resembling the external coat of an artery. Dr. Jones's account of the changes which take place in an artery after the application of a ligature, was deduced from an extensive series of experiments upon brutes. The following cases, in which I had an opportunity of inspecting these processes in some of the principal arteries of the human subject at different periods after the application of ligatures, will be found, for the most part, to corroborate his deductions.

CASE XXXIII.

A VERY old man died on the fourth day after the ligature of the external iliac artery. His powers were exhausted by a violent hæmorrhage which followed the separation of a slough from a large aneurism in the groin a few hours before the operation. The artery had been tied about two inches below the origin of the internal iliac with two thick ligatures, which were placed near to each other; but the vessel was not divided

in the interspace. None of the appearances of adhesion existed in the wound, nor was the external surface of the artery surrounded by lymph. When the ligatures were removed, and the artery was slit open in a longitudinal direction, it was found to contain a firm plug of coagulum which extended to the origin of the internal iliac. The internal and middle coats of the artery had been completely cut through by the ligatures, and the external coat alone remained entire in that situation. The extremities of the divided coats were in a state of apposition, and appeared to close the end of the vessel. There was no appearance of lymph about them, or of ulceration underneath the ligature. The inside of the vessel was of a deep red colour. The lower end exhibited the same appearances, but the plug was of a much less extent than in the upper. The absence of an effusion of lymph from the divided extremities of the internal and middle coats, and upon the external surface of the artery, was probably owing to the extreme debility of the patient, whose powers did not appear to have been sufficient to produce the adhesion of the external wound. Dr. Jones found the effusion of lymph within and around the artery had taken place in a few hours after the application of a ligature in his experiments *.

* *Treatise on Hæmorrhage*, chap. iv. experiment I.

CASE XXXIV.

THE arm of a young man was amputated in consequence of a gunshot wound of the elbow. The ligature had not separated from the brachial artery on the fourteenth day, when the patient died of fever. The external surface of the artery, near its extremity, was firmly connected to the surrounding parts by an effusion of lymph in which it was imbedded. The portion of the external coat surrounded by the ligature, and that which was situated beyond it, had a white and sloughy appearance. When the vessel was laid open in a longitudinal direction, a conical plug, about an inch in length, was found to be continued from its extremity to the origin of a considerable ramification. The internal and middle coats had been completely divided by the ligature. An effusion of lymph had taken place from the cut edges of these coats, by which the sides of the extremity of the vessel were connected. This effusion was about half a line in thickness, and was easily distinguished, by its whiteness, from the plug formed by the coagulation of the blood; the latter was of a deep purple colour. The internal surface of the artery exhibited a bright scarlet appearance, which extended to a considerable distance.

CASE XXXV.

A MAN about thirty years of age had an aneurism in the groin which was attended with prodigious swelling of the limb. The external iliac artery was tied, but he died in the third week after the operation, in consequence of the mortification of the leg. The artery was tied about half an inch below the origin of the internal iliac. Two ligatures were placed underneath the vessel, but only one of them was tied: both ligatures had separated a few days before the death of the patient. The vessel had been completely divided by the ligature, and the extremities of it were separated to the distance of half an inch. The interspace was filled with lymph, and in the centre of this effusion there was a cavity containing a very small quantity of pus. When the upper extremity of the artery was slit open, it was found to be completely empty between the point at which the ligature had been applied and the origin of the internal iliac. No plug of coagulum had formed in it. The internal and middle coats had been divided by the ligature, and an effusion of lymph, of a white colour, had taken place which closed the extremity of the canal, and was connected with that effusion which had taken place on the outside

of the vessel. The lower extremity exhibited the same appearances, excepting that it contained a plug of coagulum more than an inch in length. The base of this plug was connected with an effusion of lymph from the divided extremities of the internal and middle coats. The internal was continuous with the external effusion of lymph in the same manner as in the opposite extremity of the vessel.

I have had several opportunities of examining arteries at still greater distances of time after the application of ligatures. I have universally found the canal of the vessel obliterated, and its coats converted into a solid ligamentous cord, in which no vestiges of original structure could be traced. In most instances the obliteration extends on both sides the part at which the ligature has been applied to the origin of some considerable ramification: but this does not always occur. In a preparation that I have seen, in which the femoral artery was tied for the cure of a popliteal aneurism, the vessel was obliterated at the part at which the ligature was situated, but its cavity was of the usual dimensions for the space of nearly two inches between the commencement of the obliteration and the origin of the profunda. It contained no coagulum, nor did any branch originate from it in that situation. The man lived some years after

the operation. In Case XVIII* the femoral artery was obliterated by the pressure of an aneurism for the space of three inches before it penetrates the tendon of the adductor muscle. From the commencement of the obliteration to the origin of the profunda, its cavity remained entire, although no important branch was given off from that portion of the vessel. Two or three small arteries originated near the profunda, but no vessels arose from the last inch and a half of the canal. From the history of the case, it is probable that the parts had remained in this condition nearly twenty years.

This account of the mode by which a ligature effects the obliteration of an artery, indicates the propriety of aiding the adhesive process that is going on in the vessel, by all those means which may be deduced from the analogy which the circumstances of the case bear to those of simple wounds in general. A neglect of these considerations may lead to the employment of measures which will thwart the adhesive process, and convert the inflammation into the suppurative or gangrenous, so that the end of the vessel upon the separation of the ligature may not have healed, but being pervious, allow the occurrence of that most serious acci-

* Page 107.

dent, secondary hæmorrhage. What then are the circumstances in the mode of applying the ligature, the condition of the artery, or the treatment of the wound, which tend to produce secondary hæmorrhage?

Secondary hæmorrhage occurs at two periods after the application of a ligature to an artery:—either within a few hours after the operation, or between the sixth and the thirtieth day, when the ligature may be expected to be detached from the vessel. The cause of the first occurrence is the slipping off of the ligature from the end of the vessel, and of course it can only take place when the artery has been divided. The obstacle which that portion of the internal and middle coats situated beyond the division made in them by the ligature must afford to its slipping off when the ligature is properly applied, will in most instances be sufficient to resist this accident. But if, through a false fear of cutting through all the coats of the vessel, the ligature be not drawn sufficiently tight, or if it be too thick, or irregularly applied, it is evident that the retraction of the vessel may cause its removal. The knots with which a ligature is tied are often such, that even when the second has been made they are still capable of being drawn tighter. If the ring is capable of being diminished by drawing the ends of the ligature, it is capable of being enlarged by

their slipping in an opposite direction: hence the force of the circulation at the end of the vessel may distend the ring of the ligature from within, and render it so loose as to slip off. I have ascertained this to be the state of several ligatures with which arteries were tied, and secondary hæmorrhage occurred a few hours after amputations. If the ligature be not applied to the artery in a circular direction, but in such a manner that it embraces it irregularly and forms an oval, it is probable that when the fibres of the vessel retract and recover their natural situation, the loop will be too large to constrict the tube, and consequently it will become loose and liable to be thrown off. If a spicula of calcareous matter exist in the artery at the place where the ligature is applied, it may cut through the coats of the vessel, and in that manner give rise to hæmorrhage.

But secondary hæmorrhage generally occurs at a more remote period, namely, when the ligature may be expected to separate from the artery. The principal causes of this accident are the obstacles which the adhesive inflammation has met with in consequence of—1st, a morbid condition of the coats of the artery: 2dly, the application of an improper ligature: 3dly, its premature removal: and, 4thly, sloughing or ulceration of the vessel and surrounding parts.

1st. When a ligature is applied to an artery, the internal coat of which has undergone a steatomatous thickening, or contains a deposition of atheromatous or calcareous matter, instead of producing an effusion of lymph, and the adhesion of the extremity of the tube, the inflammation is liable to terminate in ulceration or gangrene. Although the internal coat of an artery is extremely prone to the adhesive inflammation, still when those morbid changes which I have mentioned have taken place, ulceration sometimes occurs. Under these circumstances, the ulceration from within will in some instances penetrate the sides of the vessel: in other instances, upon the separation of the ligature the extremity of the tube will remain pervious, and hæmorrhage will be the consequence. A gentleman upon whom Sir Everard Home tied the femoral artery for a popliteal aneurism, died on the twelfth day after the operation, in consequence of a violent hæmorrhage from the wound. When the artery was laid open, several small ulcerations, by which the blood had escaped, were found to have penetrated its coats close to the ligature. "There was not the smallest union of the sides of the artery; but immediately above and below the ligature the inner membrane had an unusual red appearance. The inner membrane had lost its usual polish, and had its surface covered with opaque white spots: the same appearance, in a

less degree, was seen in the artery near the groin*." Vacca operated upon a popliteal aneurism, according to Mr. Hunter's method, in an old and sickly patient. The femoral artery remained tied for twenty-five days without discharging a drop of blood; but after this time repeated hæmorrhages occurred. "On examining the body after death, Vacca found that a coalescence had not taken place between the parietes of the artery, and a clot had not formed sufficiently firm to stop up entirely its tube. On opening the femoral artery in its whole length, he observed that the internal membrane of this artery was very much thickened, everywhere indurated, and in several points cartilaginous; that at the place of the ligature the wrinkled parietes of the artery approached each other, but left a small hole in the middle above a line in circumference, the sides of which were not united, and through which a little injection had escaped, and had forced out a clot of a conical figure six lines in length, with its base towards the wound, and its apex towards the heart†." Secondary hæmorrhage, however, is by no means an universal consequence of the ligature of an artery, the coats of which have undergone

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 255.

† SCARPA, *Treatise on Aneurism*, WISHART'S *Translation*, p. 206.

these morbid changes: they exist to a greater or less degree in almost all arteries from which aneurisms originate, yet secondary hæmorrhage is a rare occurrence. Most surgeons have seen arteries successfully tied in amputations, in the coats of which depositions of calcareous matter had taken place to such an extent, that the vessel cracked under the ligature.

2dly. It is well known that the adhesive inflammation takes place more readily in clean and simple wounds, than in those that are attended with contusion and laceration; hence a ligature should be employed of such a shape as will effect a simple division of the internal and middle coats of the artery. It is desirable also that these coats should be divided throughout the whole extent of the circle, in order to produce a sufficient effusion of lymph from their cut edges to insure the complete adhesion of the tube. Dr. Jones found that the adhesion was not complete where the coats of the vessel were but partially divided*; hence arises the propriety of employing such a ligature as shall effect their entire separation. A broad ligature does not make a smooth and even wound in the coats of the artery; and in consequence of its extension beyond the point of adhesion, the subsequent ulceration which is necessary for its

* *Treatise on Hæmorrhage*, chap. iii. experiment IV.

detachment may expose the cavity of the artery above the place of its union. Flat ligatures, such as pieces of tape, &c. will effect only a partial and contused laceration of the internal coats, and like the broad ligature, by extending beyond the point of adhesion and exciting ulceration, will lay open the cavity of the vessel, and give rise to hæmorrhage. From the same reasoning it is evident how opposite to the processes of obliteration is the employment of gradual or extended pressure, which, instead of operating upon the internal coats of the artery, produces ulceration from without, and exposes the cavity of the vessel. Hence also the impropriety of surrounding the artery with cylinders of linen, plates of cork or wood, slices of agaric, *serre-artères*, *presse-artères*, *ligatures d'attente*, and a variety of inventions which have been employed for the purpose of preventing, but which in fact tend to produce secondary hæmorrhage *.

* In one operation Mr. Hunter applied four ligatures to the femoral artery. The two upper ligatures were tied only so slightly as to place the opposite sides of the vessel in contact. Mr. Birch passed two ligatures underneath the artery; the lower was tied; the upper remained loose, for the purpose of being tied in the event of hæmorrhage. The loose ligature was termed the *ligature d'attente* by the French surgeons, who generally employed it in their operations. Mr. Cline passed a double tape about one inch broad behind the artery; one piece of tape lying over the other. A piece of cork

When surrounding parts are included in the ligature with which an artery is tied, it is difficult to calculate the degree of force which is requisite to

nearly an inch long was laid upon the artery, and confined to its situation by means of the upper tape, producing in this way a sufficient pressure upon the vessel included between the ligature and cork to stop the circulation. The other portion of tape was left loose. Mr. Forster passed a broad ligature by means of a common eyed-probe, placing a dossil of lint on the artery immediately over the ligature, upon which lint was laid a cylindrical piece of wood about a third of an inch in diameter, and three quarters of an inch long, so that on tying the ligature, the artery, lint, and stick, became included in such a manner as to make the artery spread itself more than half round the stick thus chusioned with the dossil of lint. Scarpa passed two ligatures, each composed of six threads, underneath the denuded artery. He then placed a small cylinder of linen rolled up, six lines in length and three in breadth, upon the vessel, and secured it in that situation by tying both ligatures. The wound was afterwards filled with lint. Deschamps interposed a slice of agaric between the ligature and the artery. He invented also an instrument termed the *serre-artère*, by which the artery might not only be compressed, but the ligature tightened from time to time, as the surgeon might judge necessary. It consisted of a silver button and a stalk: the stalk allowed the instrument to go down to the bottom of the wound: the flat button was to rest upon the artery as a smooth compress; and in the button were two slits, through which the flat ligature surrounding the artery passed, the ends of the ligature being fixed with a knot over the top of the stalk, and tightened as occasion required. A slice of agaric was also

divide the internal and middle coats of the vessel. The surrounding parts included in a ligature with

interposed between the ligature and the button of the *serre-artère;* a *ligature d'attente* was placed underneath the vessel above this machine. The artery was constricted by this contrivance in a manner somewhat similar to that by which a polypus is tied with the canula of Levrèt, or the loop of Hildanus. M. Percy invented an instrument somewhat like a pair of pincers: the blades were furnished with two flat surfaces, between which the artery was compressed: the degree of pressure was increased according to the wish of the surgeon. Such are the principal contrivances by which it has been proposed to effect the adhesion of the sides of an artery. They are now universally discarded from the practice of the most experienced surgeons in this country, who, both from reason and experience, prefer the simple ligature to these mechanical refinements. Upon the Continent, however, they are still employed. Scarpa strongly urges the interposition of a cylinder of linen between the ligature and the artery. Richerand and Léveillé mention the employment of the *presse-artère* by Dubois, in the year 1810, at which time M. Duret published an account of an instrument very like the pincers of M. Percy, which he proposed as a substitute for the ligature.—See Sir EVERARD HOME'S *Papers on Aneurism, in the Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. ii. Mr. FORSTER'S *Account of Two Cases of Popliteal Aneurism in Medical Facts and Observations*, vol. v. SCARPA, *Treatise on Aneurism*, WISHART'S *Translation*, p. 267. DESCHAMPS, *Obs. et Reflexions sur la Ligature des Artères Blessées, et sur Anévrisme de l'Artère Poplitée*, p. 21. *Dictionnaire des Sciences Médicales, Art. Anévrisme.* LEVEILLE, *Nouvelle Doctrine Chirurgicale*, tom. iv. p. 247.

an artery, generally slough or ulcerate: if these effects extend to the coats of the vessel, its cavity will be liable to be exposed, and hæmorrhage to ensue*. Independent, therefore, of the cruelty of including surrounding parts, it is desirable that an artery should be completely detached from its connexions before the application of a ligature.

3dly. The importance of absolute quietude in promoting the adhesion of wounds in general, indicates the necessity of its observance after the ligature of an artery. The facility with which recently cicatrized surfaces are torn asunder, proves how readily the slender point of adhesion at the extremity of a tied artery may be separated by the exertions of the patient. Petit† imputed hæmorrhage on the twenty-first day after amputation to the patient's suddenly raising himself in bed: many similar instances might be adduced if the fact were not of frequent occurrence. Improper attempts to expedite the detachment of the ligature, by twisting it or pulling its extremities, may cause its removal before the adhesion at the end of the vessel is sufficiently firm to resist the impulse of the circu-

* Pouteau included the crural nerve of a dog, together with the artery, in a ligature. The animal died of hæmorrhage on the fifth day, in consequence of the ulceration of the vessel. — *Mélanges de Chirurgie*, p. 302.

† *Mémoires de l'Acad. Roy. des Sciénces*, An. 1732.

lating blood, or the violence employed may destroy the union. There are few surgeons who have not witnessed secondary hæmorrhage from these causes after amputations.

The impulse of the circulation has appeared in some instances to force asunder the recently cicatrized extremity of the tube, and in that manner to produce secondary hæmorrhage. The existence of a plug serves in most instances to remove the force of the circulation from the point of adhesion in the artery, and to prevent the occurrence of this accident. The formation of a plug, however, is not a constant occurrence; and when an artery is tied close to a considerable ramification, it rarely takes place. Under such circumstances, upon the detachment of the ligature, the recent adhesion is liable to be forced asunder by the impulse of the circulating blood. Hæmorrhage occurred on the fourteenth day after the operation, in a patient upon whom Mr. Astley Cooper tied the femoral artery underneath Pauart's ligament. It was found that the vessel had been tied close to the origin of the epigastric artery. A plug did not exist in its cavity, and the adhesion at the extremity of the vessel appeared to have been lacerated by the impulse of the circulation*. The formation of a plug does

* This case is mentioned in Mr. ALLAN BURNS' *Observations on Diseases of the Heart*, p. 230.

not invariably happen even when an artery is tied at a distance from the origin of a ramification: under these circumstances, however, the ligature may be detached without the occurrence of hæmorrhage. In Case XXXV*, the artery was tied about half an inch below the origin of the internal iliac: a plug did not exist in its cavity, and yet in so large a vessel, situated so near to the heart, and exposed to so powerful a current, the adhesion effected by the ligature was sufficiently firm to resist the impulse of the circulating blood. The possibility of hæmorrhage from the cause which I have now mentioned, points out the impropriety of tying an artery close to the origin of an important ramification, and leads us to prefer the application of a ligature to a portion of the vessel which is free from the commencement of collateral branches.

4thly. The most frequent cause of secondary hæmorrhage is the ulceration or sloughing of the extremity of the artery, whereby its cavity is exposed above the point of its obliteration by the ligature. This accident is generally produced either by the sloughing or ulceration of the vessel in conjunction with the surrounding parts, or by the occurrence of those conditions in the artery alone, in consequence of the employment of improper contrivances to effect its obliteration, or

* Page 198.

of improper modes of treating the wound. All those causes which excite ulceration or sloughing of wounds in general, will be liable to produce these effects after the operation for aneurism. Amongst these may be reckoned an irritable habit, prone to a high degree of inflammatory action; the diminution of vital power by long continued disease; and gangrene which occasionally pervades the wards of crowded hospitals. Mr. Abernethy* tied the femoral artery in a lady of a very irritable constitution. Fever came on, and restlessness, which continued for twenty-four hours: although these symptoms were then mitigated, they still existed in a considerable degree. On the third day a fatal hæmorrhage took place. The whole surface of the wound was in a sloughing and putrid state. The artery being slit downwards from the groin, was highly inflamed on its internal surface, and terminated by an orifice which was of a pulpy feel, and had a sloughy appearance like the surface of the wound. "The only rational explanation," says Mr. Abernethy, "which I can form of this case is, that from a peculiar irritability of constitution, the patient was unusually affected by an operation which would ordinarily have been borne without any prejudicial derangement of health; and that the

* *Surgical Observations, on Aneurism*, p. 229, first edition.

constitution and the parts were disturbed in such a manner as terminated in the sloughing of the wound, and in that of the artery immediately above the place where it was tied." In Case XXXIII*, the entire absence of the adhesive processes on the fourth day after the ligature of the external iliac artery, was probably owing to the extreme debility and want of power which was induced in an aged patient by long sufferings and attempts to effect a spontaneous cure of the aneurism by depletion and abstinence. In the following case hæmorrhage was produced by the sloughing of a stump in a large hospital in which gangrene appeared at that time to be contagious.

CASE XXXVI.

THE thigh of a young man was amputated for a disease in the knee. The femoral artery was tied with a thin ligature. The stump went on well during the first week, when sloughing of its whole surface took place, and hæmorrhage occurred on the twelfth day. The bleeding was so violent, that no doubt was entertained that it came from the femoral artery. Various topical means were ineffectually employed to restrain the hæmorrhage. The sloughy condition of the stump precluded the possibility of finding the vessel upon

* Page 195.

its surface; the femoral artery was therefore tied about three inches below Paupart's ligament. The operation restrained the hæmorrhage. The ligature separated in a fortnight; the sloughing of the stump ceased; and after a tedious exfoliation the patient recovered.

Another cause of secondary hæmorrhage is the sloughing or ulceration of the surface of the wound, in consequence of the employment of an improper degree of violence in the performance of the operation, or of improper treatment afterwards. The detachment of the artery from its connexions for a considerable extent, by depriving it of the sources of its vitality, may cause it to slough; and in this case, upon the separation of the ligature, hæmorrhage is liable to ensue. It was probably owing to the causes which I have now mentioned, that secondary hæmorrhage took place in several cases which occurred soon after Mr. Hunter first performed the modern operation. The femoral artery was at that time tied where it is situated at a considerable distance from the surface of the limb. The parts were much lacerated in searching for the vessel, which in most instances was detached from its connexions to a great extent, and secondary hæmorrhage was occasionally the consequence. But the most prolific source of this accident has been the employment of various contrivances which were invented for the purpose of preventing secondary

hæmorrhage, but which, by rendering it necessary that the artery should be detached to a considerable extent for their application, and by exciting ulceration and sloughing of its coats, tend to promote that occurrence. In the first case upon which Mr. Hunter performed the modern operation, four ligatures were applied to the femoral artery*. Two of them were tied so slightly as only to compress the sides of the vessel together. On the ninth day there was a considerable discharge of blood from the wound. Abscesses and sinuses in the vicinity of the artery were repeatedly produced by the continuance of these foreign bodies in the wound, for it was seven months before all the threads were discharged. Mr. Birch† applied two ligatures around the femoral artery: the lower one only was tied; the upper was left to be secured in the event of hæmorrhage. The man died on the fourteenth day. Upon the removal of the dressings, a small stream of fresh arterial blood was found to have issued from the wound. Water injected by the external iliac artery escaped freely from the wound at the ligature where the artery was open, and appeared to have ulcerated. Mr. Cline‡ passed a double tape, about an inch in breadth, underneath the femoral

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 174.

† Ibid. p. 166. ‡ Ibid. p. 174.

artery: a cork, nearly an inch long, was laid upon the vessel, and confined to its situation by means of the upper tape: the other tape was left loose. On the ninth day the tapes were removed, and every thing appeared to be going on favourably, when the patient was attacked by fever, of which he died. Upon examining the state of the limb after death, it was found that ulceration had taken place through the whole extent of the artery included in the tape, and sinuses were formed, both upwards and downwards, in the course of the thigh to some distance. It is unnecessary to increase this list of cases to prove a fact so palpable, as that the separation of an artery to a considerable extent from its connexions, and surrounding it with extraneous bodies, may produce ulceration of its coats and secondary hæmorrhage. Independent of tying the artery where its coats are more likely to be in a healthy condition, and are not liable to be involved in the sloughing, which generally follows the incision of an aneurismal sac, it is a material advantage that in the modern operation the artery is tied in a situation where it is possible to promote the effects of the ligature by the immediate adhesion of the surrounding parts. The security afforded by a deposition of lymph on the external surface of the artery is thus obtained, and the processes by which its obliteration is effected are

in every way promoted. It is desirable, therefore, that no extraneous substance, except the ligature, should be placed in contact with the artery: hence the impropriety of dressing the wound to the bottom by filling it with lint. In the second case in which Mr. Hunter performed the modern operation, ulceration of the artery and a fatal hæmorrhage appeared to be produced by this treatment*. The introduction of extraneous bodies into the wound causes the formation of abscesses and sinuses, which extending in the course of the artery, may expose its cavity above the adhesion effected by the ligature. Mr. Abernethy† has related a case in which the cavity of the external iliac artery was laid open by the extension of ulceration to its coats from an adjoining lymphatic gland; and Mr. Travers‡ met with an instance in which the upper extremity of a divided femoral artery was destroyed by the formation of an abscess in its vicinity after the first processes of its obliteration had been accomplished. I have seen the femoral artery laid open by a sinus which followed a compound fracture of the femur. A fatal hæmorrhage was the consequence. The vessel appeared to have been de-

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 158.

† *Surgical Observations, on Aneurisms*, p. 246. Second edit.

‡ *Medical and Chirurgical Transactions*, vol. iv.

stroyed by ulceration in common with the surrounding parts. Its coats were not in the least degree inflamed, nor did it contain lymph or coagulum. These facts show the danger which sometimes attends the formation of abscesses and sinuses in the vicinity of large arteries, and point out the propriety of obviating their occurrence after the operation for aneurism, by promoting the immediate adhesion of the wound.

Secondary hæmorrhage, however, does not invariably attend the destruction of the extremity of a tied artery by sloughing or ulceration. The existence of a plug in its cavity sometimes proves a sufficient barrier to resist the effusion of blood.

CASE XXXVII.

THE thigh of an old man who had been long afflicted with a disease of the knee was amputated. Ulceration, and finally sphacelation of the stump took place, and he died in a fortnight. The ligatures had separated. When the sloughs were removed, the extremity of the femoral artery, plugged with coagulum, was seen upon the surface of the stump. Upon laying open the vessel, its cavity was found to be completely filled with a clot four inches in length, which, together with the coats of the artery, terminated as abruptly upon the surface of the stump as if they had been divided with a knife.

In such cases the plug which is produced by the application of a ligature answers the same purposes as that which forms in the vessels spontaneously and prevents hæmorrhage when a limb is destroyed by sphacelation. In the latter instance, all the blood vessels for a considerable distance above the mortified part are filled with coagulum, which prevents the occurrence of hæmorrhage. The plug, however, which is formed after the application of a ligature, is sometimes so short and slender, that it is forced out by the impulse of the circulation, or allows the escape of blood by its sides, when the resistance afforded by the ligature or the adhesion of the extremity of the vessel is destroyed. In Pouteau's Experiment, in which the ulceration of the artery appeared to be the consequence of including a nerve together with the vessel in a ligature, the plug was not sufficiently broad to fill the tube, and it was so far forced out by the impulse of the circulation, that the middle of it was situated opposite to that part of the artery to which the ligature had been applied *. A case has been related to me in which a plug an inch in length was thrown out of a femoral artery, the extremity of which had sloughed, after the application of a ligature. The success which has attended cases in which arteries

* *Mélanges de Chirurgie*, p. 30.

were tied for the cure of aneurisms with numerous ligatures, or were compressed by extraneous bodies, was probably owing to the existence of an extensive plug in the vessel; for these practices, even if they did produce a partial division of the internal and middle coats, would in most instances be attended with ulceration of the vessel beyond the point of adhesion.

The frequency of secondary hæmorrhage after the operation for aneurism, when compared with the rarity of its occurrence after amputation, suggested the propriety of applying two ligatures, and dividing the vessel in the interspace. It was conceived that the retraction which takes place under these circumstances would place each extremity of the vessel in the same condition as that of an artery tied upon the surface of a stump. This practice, which has been revived by Mr. Abernethy*, was recommended by Œtius†, Tenon‡, and several other surgeons. Recent experience has proved the success which attends its employment; and secondary hæmorrhage, from an artery which has been tied in this manner, is, I believe, not recorded as having taken place in any of the numerous instances in which the practice has been

* *Surgical Observations, on Aneurisms*, p. 227. Second edit.

† Serm. iv. Tetr. iv. cap. 10.

‡ PELLETAN, *Clinique Chirurgicale*, tom. i. p. 192.

adopted in this country*. Scarpa, however, alludes to two instances in which it happened†. The frequent occurrence of this accident, after the introduction of Mr. Hunter's operation, may be ascribed to more probable causes than the condition of an undivided artery upon which a ligature has been applied. The employment of numerous ligatures gradually tightened, or the introduction of extraneous bodies into the wound, are sufficient to produce ulceration of the artery: such practices were adopted in most of the cases in which secondary hæmorrhage took place. An artery tied in two places, and divided in the interspace, cannot be regarded as placed exactly in the same condition as an artery tied in amputation. In the latter case the retraction of the vessel corresponds with that of the surrounding parts which are divided at the same instant, and therefore its relative connexions stand as before the operation. But in the operation for aneurism the retraction of the artery takes place without being attended with a corresponding retraction of its

* The case related by Mr. Abernethy (*Surgical Observations, on Aneurisms*, p. 229, first edition) cannot be regarded as an exception to this assertion, since the ulceration of the artery appears to have arisen from a constitutional, and not a local cause.

† *Treatise on Aneurism*, WISHART's *Translation*, p. 283.

connexions. How far the retraction of the artery is beneficial or injurious, is by no means evident, and the advantages arising from it may in most situations be obtained, without dividing the vessel, by placing the limb in a bent position. One important object, however, is gained by the division of the artery, namely, that it is generally in that case tied close to its connexions; and it is very evident how liable the application of a ligature in the middle of a denuded extent of the vessel must be to produce ulceration or sloughing of its coats. The same object, however, will be gained by tying the undivided artery close to its connexions at the end nearest to the heart, and the existence of a single ligature at the bottom of the wound will be less liable to give rise to suppuration and the formation of sinuses than the employment of two. When an artery is divided, the portions situated beyond the ligatures must slough, and prove an additional cause of suppuration in the wound. Experience has amply proved the safety of employing a single ligature, and it is at present used by many of the most experienced operators in this country. I have seen sixteen cases in which a single ligature has been applied with complete success for the cure of aneurisms to the external iliac, the femoral, and the radial arteries. I have met with only three instances upon record in which secondary hæmorrhage followed the employment of a single

ligature, unless additional extraneous bodies were left in the wound*.

In some situations both ends of the artery are exposed to the impulse of the circulation, and the failure of the adhesive process in either extremity of the vessel may be attended with a fatal hæmorrhage. Thus after the ligature of the carotid artery the anastomosing channels within the skull are so large and numerous, that a stream of blood immediately passes into the upper extremity of the tied artery, which may therefore be regarded as placed in a similar condition to the end next to the heart. The same circumstance exists in the third order of arteries, as the radial, the ulnar, the tibials, and in their ramifications, for the anastomoses become more frequent as the vessels diminish in size, and a free passage for the blood into the inferior extremity of the vessel is thus afforded. In these situations, in order to insure the

* In two of these cases the processes of obliteration were prevented by a morbid condition of the coats of the vessel: in the third, a plug did not exist in the artery, and the adhesion of its extremity was forced asunder by the impulse of the circulation on the fourteenth day after the operation. Under such circumstances the occurrence of hæmorrhage could not be imputed to the mode in which the ligature was applied. See *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 255. SCARPA, *Treatise on Aneurism*, WISHART'S *Translation*, p. 206, and Mr. Astley Cooper's Case which I have mentioned at p. 210.

adhesion of both ends of the artery by tying them close to their connexions, and that neither extremity may be left in a detached condition, and from that cause slough or ulcerate, the application of two ligatures is advisable. But the propriety of dividing the vessel in the interspace when the carotid artery is the subject of the operation, is still doubtful; for if the operation has been performed low in the neck, and the ligature should from any cause slip off, it will be impossible again to secure the vessel, or permanently to command the hæmorrhage. For the reasons which I have stated, full confidence, I conceive, may be placed in the employment of a single ligature, unless during the operation the artery be detached from its connexions for a considerable extent. In that case I should prefer the application of two ligatures, in order to insure the adhesion of both ends of the vessel; but the division of it in the interspace I conceive to be of little importance.

The preceding remarks appear to justify the following conclusions as to the proper mode of applying a ligature to an artery.

First: The cord should be thin and round, such a ligature being most likely to effect a clean division of the internal and middle coats of the vessel, and not liable to occasion extensive ulceration or sloughing.

Secondly: The ligature should be tied very tight, in order to insure the complete division

of the internal and middle coats, and to prevent its detachment, it being almost impossible, even with the thinnest ligature, entirely to cut through a healthy artery *.

Thirdly: The vessel should be detached from its connexions only to such an extent as is necessary for the passage of the ligature underneath it.

Fourthly: The immediate adhesion of the wound should be promoted by all those means which assist that process in general.

* The common knot is preferable to that termed the surgeon's knot, because with it the operator is enabled with greater accuracy to calculate the degree of force necessary to cut through the internal and middle coats of the vessel. It is also smaller, and does not make that irregular pressure upon the artery which is produced by the surgeon's knot. It is not true that the latter is incapable of slipping, although it is more difficult to draw it tighter after the second knot is made than when a common knot has been employed. After a second is made, there will be little danger of the ligature becoming loose from the slipping of the common knot; but if the surgeon apprehends that occurrence, it may be easily guarded against by making a third. In consequence of the circular depression which is produced by the division of the internal and middle coats, the ligature, if applied with sufficient tightness, is not liable to be thrown off the vessel by the impulse of the circulation. The proposal, therefore, is unnecessary, of passing one end of the ligature by means of a needle through the artery beyond the point at which it is tied, and retaining it in that situation by means of a knot. If the ligature be properly

Lastly: Experience having proved that secondary hæmorrhage more frequently arises from an improper mode of tying the artery or of treating the wound, than from the condition of an undivided artery, the practice of applying two ligatures and dividing the vessel in the interspace is not an essential object. But in situations where there is a vigorous circulation at both ends of the vessel, the application of two ligatures is advisable.

In the course of his experiments upon brutes to ascertain the operation of the ligature, Dr. Jones arrived at a fact which offered the proba-

applied, there will be no danger of its detachment; and if it be tied loosely, this precaution will not prevent its slipping. The practice was recommended by Dionis and Richter. It has lately been revived by Mr. Henry Cline.—See *Medical and Physical Journal*, vol. viii. p. 5.

It is the custom of some surgeons, and has even been recommended by systematic writers, to lay aside the knife as soon as the integuments are divided, and to search for the artery by tearing the parts asunder with the finger or some blunt instrument. This practice is highly reprehensible, because a wound thus made by laceration cannot be expected to unite by the first intention, which is a most important object after the operation for aneurism. This mode of operating is never employed but as a substitute for that familiar acquaintance with the situation and connexions of the great arteries, which every surgeon ought to possess, and without which no man is qualified to undertake an operation for aneurism. The integuments and cellular membrane should be divided with a knife until the sheath of the artery is

bility of affording an improvement in the operation for aneurism*. When a ligature is applied to an artery, it causes a division of the internal and middle coats; and if it be afterwards removed, an effusion of lymph takes place from the cut surfaces into the cavity of the vessel. If several divisions of the internal and middle coats be thus effected in the vicinity of each other, the effusion of lymph was found by Dr. Jones to be sufficiently extensive to obliterate the cavity of the vessel. When the circumstances which determine the suc-

exposed, which in most instances may be opened in a similar manner. This part of the operation may generally be effected with facility, if pressure be made upon the superior portion of the artery so as to stop the circulation through its canal, and render it in some degree flaccid. The ligature should then be conveyed underneath the artery by means of an aneurism needle mounted in a handle, which is passed through the cellular membrane immediately connecting the vessel to the adjacent parts: this is the only part of the operation which it is necessary in most situations to effect by laceration. The practice of passing the finger underneath the artery and raising it from its connexions, is also unnecessary and highly injurious: it is not essential for the proper application of the ligature, and increases the chance of suppuration in the bottom of the wound. The artery should be detached as little as possible from its natural connexions, and every thing should be avoided both in the operation and the treatment afterwards which can impede the immediate adhesion of the parts.

* *Treatise on Hæmorrhage*, chap. iii.

cess or failure of this experiment were ascertained, it appeared very probable that it would constitute an improvement in the mode of applying the ligature for the cure of aneurism. In consequence of the removal of the ligature, nothing is left in the wound which can prevent its immediate union, and the chance of secondary hæmorrhage, from the sloughing or ulceration of the artery, is very much diminished. Subsequent experimentors have not, however, been equally successful with Dr. Jones in obtaining the obliteration of the cavity of the vessel after this operation. In the following instances the experiment was performed precisely in the manner described by Dr. Jones: in neither of them was the cavity of the vessel obliterated, although each exhibited the process by which that object may be effected.

EXPERIMENT A.

THREE ligatures were applied to the carotid artery of a large dog at the distance of about the sixth of an inch from each other. They were tied so tight as completely to divide the internal and middle coats of the vessel; and, being immediately removed, the circulation through the tube was ascertained to be re-established. The dog speedily recovered. At the expiration of three months he was destroyed. The vessel was found to be still pervious, but an effusion of lymph had taken place

into its cavity at the part where the three wounds had been inflicted upon the internal coats by the ligatures. This effusion formed three strictures in the tube, which was thereby reduced to about one-half of its natural capacity. When the lymph was detached, it was evident that the internal and middle coats had been completely divided; but the effusion was not sufficient to obliterate the cavity of the vessel.

EXPERIMENT B.

THE above experiment was repeated upon both the carotid arteries of a dog at the same time. He was destroyed at the end of four months after the operation. The effusion of lymph had not proceeded to so great an extent as in Experiment A. The internal and middle coats of the artery had been divided by the ligatures, but the effusion of lymph from the cut surfaces was so trifling, as merely to produce three slight strictures in the cavity of the vessel.

From these experiments, which were performed with considerable accuracy, it is evident that the effusion of lymph from the divided coats of the vessel will not, in every instance, proceed to such an extent as to obliterate the tube. They have been repeated by several surgeons upon the arteries of dogs and horses, but I am not acquainted with any instances, except those related by Dr. Jones,

in which the complete obliteration of the cavity of the vessel has been accomplished. It appears, however, that an effusion of lymph is an invariable consequence of the operation: the want of union is therefore owing to the opposite sides of the vessel not being retained in a state of contact so as to allow of their adhesion*. The presence of the ligature, in the common mode of its application, effects this object; and for the success of Dr. Jones's experiment it appeared only necessary that the opposite sides of the wounded vessel should be retained in contact until their adhesion is sufficiently accomplished to resist the passage of the blood through the tube. This object might probably be effected by compression; but the inconveniences attending such a degree of pressure as shall retain the opposite sides of an artery in contact at the bottom of a recent wound are too great to permit its employment. It occurred to Mr. Travers, that if a ligature were applied to an artery, and suffered to remain only a few hours, the adhesion of the wounded surfaces would be sufficiently accomplished to insure the obliteration of the canal; and by the removal of the ligature at this period, the inconveniences attending its stay would be obviated. The danger produced by the

* See *Observations on the Application of the Ligature to Arteries*, &c. by Mr. Travers, in the fourth volume of *the Medico-Chirurgical Transactions.*

residence of a ligature upon an artery arises from the irritation which, as a foreign body, it produces in its coats. Ulceration has never been observed to commence in less than twenty-four hours after the application of a ligature; whilst it is an ascertained fact, that lymph is in a favourable state for organization in less than six hours* in a wound the sides of which are preserved in contact. If it be sufficient, therefore, to insure their adhesion, that the wounded coats of an artery be kept in contact by a ligature only three or four hours, ulceration and sloughing may in a great degree be obviated by promoting the immediate adhesion of the wound. Justified by this reasoning, Mr. Travers performed several experiments, by which he ascertained, that if a ligature be kept six, two, or one hour upon the carotid artery of a horse, and then removed, the adhesion was sufficiently advanced to effect the permanent obliteration of the canal. It appeared probable that the same result would be obtained upon the healthy artery of a human subject. The removal of the ligature before it was detached by ulceration has been practised by some surgeons who conceived that its operation was confined merely to the approximation of the sides of the vessel, and that their adhesion was sufficiently accomplished in the

* Jones *on Hæmorrhage*, chap. iv. experiment I.

course of a few days. With the intention of promoting the enlargement of the collateral branches by the gradual obliteration of the trunk, M. Dubois gradually tightened the ligature until the pulsation in the tumour ceased, after two operations for popliteal aneurism. This object was effected in a few days, when the ligature was removed, without being allowed to remain upon the vessel a sufficient time for its detachment by ulceration. The external wound was united by the first intention, and the patients were speedily cured*.

Although the obliteration of a healthy artery may follow the removal of a ligature a few hours after its application, still it appears by no means improbable, when the coats of the vessel are in a morbid condition, that the ulcerative, and not the adhesive inflammation, may be the consequence of the irritation excited in them by the operation. We have seen that the failure of the ligature, in the common mode of its application, is sometimes owing to a morbid condition of the coats of the artery, which renders them unfit for adhesion†. We know also that aneurisms are frequently accompanied with a destruction of the internal and middle coats of the vessel; and it appears probable

* Leveille, *Nouvelle Doctrine Chirurgicale*, tom. iv. p. 247, 283. *Dictionnaire des Sciences Médicales, Art. Anévrisme.*

† Page 203.

that in many instances their formation is owing to that circumstance. Most patients date the commencement of this disease in the extremities from some violent exertion, by which the internal and middle coats of the vessel, having lost their natural elasticity by disease, are suddenly torn asunder. Is it not probable, then, if the internal and middle coats of a diseased artery be cut through by a ligature, and the wound be not repaired by the adhesive inflammation, that the impulse of the circulation may distend the external coat into a sac, and the formation of an aneurism be the consequence? If a plug be formed in the artery during the residence of the ligature upon it, or in consequence of the effusion of lymph from the cut surfaces, it may prevent these occurrences; but the formation of a plug is an event which cannot be depended upon, and which does not take place in all cases where the ligature is suffered to remain upon the artery*. If the impulse of the circulation against the recently united surfaces be not obviated by the existence of a plug, the adhesion may be torn asunder, and the continuity of the tube restored. The force of the circulation has been known to destroy the adhesion of the extremity of an artery in which a plug had not formed, on the fourteenth day after the application of a liga-

* Page 210.

ture, with which the femoral artery had been tied for an inguinal aneurism. The copious effusion of lymph which takes place around the external surface of the artery after the application of a ligature, will tend in some degree to resist the distension of the external, when the internal and middle coats are divided: but can this effusion afford sufficient resistance to the impulse of the circulation, which, when its natural confines are removed, will extenuate ligaments and tendons, and even destroy the bones?

The facts ascertained by Dr. Jones and Mr. Travers by experiments upon brutes, appear to justify a trial of the practice upon the human subject in a case where it is most likely that the coats of the artery are in a healthy state. If successful, it will constitute a valuable improvement in the operation for aneurism, and will remove the dreadful suspense which ensues from the period at which a ligature is applied, until it is detached from the artery. The merits of the proposal, however, can be determined only by experience.

Secondly. I shall now consider those changes which take place in the arterial system of a limb when the main artery is rendered impervious by the application of a ligature.

The blood meeting with an obstacle to its progress through the accustomed channel, is thrown in

greater quantity, and with greater force, into those branches which arise above the seat of the obstruction. The ramifications of these branches, in consequence of the unusual influx of blood, undergo a remarkable dilatation: the more minute vessels also by which they anastomose with corresponding ramifications arising from branches given off below the obstruction, are from the same cause sufficiently enlarged to allow a free passage for the blood into the inferior trunks of the limb. At first the circulation is in this manner carried on through a congeries of minute anastomosing arteries: in a short time a few of these channels become more enlarged than the rest: as these increase in size, the smaller vessels gradually collapse, and ultimately a few large communications constitute permanent channels through which the blood is transmitted to the parts that it is destined to supply. This is one mode by which a collateral circulation is established.

But in some situations more direct and ostensible inosculations are provided; so that when one channel is obstructed, the blood passes at once through the other in a sufficient stream for the nourishment of the part which it is destined to supply. Under these circumstances, no dilatation of the collateral branches is necessary: the circulation, in such instances, may be said to be constantly carried on through inosculating trunks. These great com-

munications principally exist in the extremities of the body, where the dilating impulse which the blood receives from the heart is of course diminished. Thus the radial artery inosculates freely with the ulnar, the anterior with the posterior tibial, and the internal carotid with the vertebral arteries. Two modes therefore exist by which arteries communicate with each other—the anastomoses of minute ramifications,—and the direct inosculations of trunks.

That the communications between the minute arteries are sufficiently numerous and extensive, even in their natural state, for the transmission of blood from one extremity to the other of a part, the main trunk of which is suddenly rendered impervious, is proved by tying the main artery of a limb, and injecting the upper portion of the vessel even with coarse injection. The wax will be found to have permeated the most remote branches, and dissection will prove that it has not passed through any large communications, but through an extensive plexus of minute arteries. Cases have repeatedly occurred in which the principal arteries of the extremities were successfully tied in consequence of wounds. In these instances no previous circumstances can have caused a gradual dilatation of the anastomosing branches, which appear to have immediately supplied a sufficient quantity of blood for the support of the limb,

when the principal artery was suddenly rendered impervious.

If an artery be tied a short time before the death of an animal, and the limb be injected, the circulation will be found to have been carried on in a similar manner through the anastomoses of minute ramifications; but the vessels are much larger and infinitely more numerous than when the experiment has been made after death. When the blood is obstructed in its passage through the principal artery, the anastomosing branches therefore undergo a speedy and remarkable dilatation. This fact is apparent, if an artery be divided in the conjunctiva. As soon as the hæmorrhage ceases, vessels which were invisible before the operation may be observed to afford a passage to the blood from one portion of the divided artery to the other. Haller* observed the dilatation which took place in the anastomosing branches after the ligature of the mesenteric artery in frogs, whilst they were exposed under a microscope. After amputations, whilst the blood is permitted to flow from the main artery, a comparatively small quantity is discharged from the lateral branches: immediately that the trunk is tied an increased current issues from these vessels, and when they are secured the blood oozes from innumerable orifices, which were imperceptible in an earlier stage of the operation.

* *Opera Minora*, vol. i. exp. 54.

If a limb be dissected at a greater distance of time after the obliteration of its main artery, the circulation will be found to have been carried on in a different manner from that which I have now described. Instead of the numerous and extensive vascular anastomoses which are met with at an earlier period, only a few will be observed; and these having acquired a considerable size, communicate freely with branches arising below the ligature, and form permanent channels through which the circulation is carried on. The numerous anastomosing branches therefore, which were dilated soon after the ligature of the trunk, collapse as the circulation becomes established through a few of the larger vessels.

This account of the changes which take place in the arteries, by which a collateral circulation is performed when the main channel is rendered impervious, is confirmed by experiments upon brutes, and by the dissection of limbs at different periods after the principal artery has been tied for the cure of aneurisms. Dr. Jones tied the right femoral artery of a dog thirty-seven days, and the left forty-nine days, before the animal was killed. The posterior extremities were injected from the aorta. In the right limb the muscles of the thigh were most minutely injected, and several larger anastomoses were traced between the ischiatic, the profunda, and several arteries about the knee. In the left extre-

mity the principal anastomoses appeared somewhat larger; but the muscles of the thigh, although very vascular, by no means exhibited so many vessels as those of the opposite limb. In another experiment, a dog was killed eighty-one days after the ligature of the femoral artery. The anastomoses were much larger, and the limb did not exhibit that minute and extremely vascular appearance which was observed in the experiments above referred to. The anastomosing branches had a very serpentine course; the artery was much convoluted, and most of the anastomoses formed small circles; thus when two branches, one from above, and the other from below, approached each other, at some little distance before they met, each divided into two smaller branches, which anastomosing with each other, formed a small circle or oval. The few anastomoses which were found in the limb, the main artery of which had not been tied, were extremely small, and formed by branches passing in a direct line with each other, not in the least tortuous*. An old man, whose case I have already mentioned†, died on the fourth day after the ligature of the external iliac artery for an aneurism in his groin. The limb was injected from the common iliac artery, and I had an opportunity of witnessing

* Jones *on Hæmorrhage*, chap. iv. sect. 1. exp. XI. XII. XIV.

† Case XXXIII. p. 195.

the dissection. The wax had passed by numerous anastomoses from the branches of the internal iliac artery into those of the profunda. These communications were so minute, that only a few of them were capable of being traced. The injection had not sufficiently succeeded to fill the femoral artery, but it was evident that the blood had passed from the branches of the internal iliac into those of the profunda by numerous minute anastomoses*. Mr. Astley Cooper dissected a limb, in which the external iliac artery had been tied ten weeks and six days before the death of the patient. The circulation was carried on through numerous ostensible anastomoses between the branches of the internal iliac, and those of the profunda, the epigastric, and pudendal arteries. In another preparation in the possession of Mr. Cooper, the external iliac artery had been tied nearly three years before the death of the patient. At that distance of time after the estab-

* The common modes of injection frequently fail where the circulation has been carried on through collateral branches, more especially if the main artery has been recently obstructed, and the anastomosing communications are very minute. Under such circumstances it is desirable to introduce a pipe into one of the inferior trunks, and to inject the limb from below as well as from above. Even then, in the course of the dissection branches will often be found which the injection has not penetrated. The preparation will be rendered more complete if a pipe be introduced, and a little injection be thrown into these branches.

lishment of a collateral circulation, the anastomosing channels were by no means so numerous as in the other preparation, but considerably larger in diameter*. Mr. White dissected the arm of a woman fourteen years after the ligature of the brachial artery. The injection passed into the fore arm through a few large anastomosing communications between the branches of the brachial and the recurrent radial and ulnar arteries. These channels had acquired so large a diameter, that when taken together they exceeded the size of the brachial artery above the part at which it was obliterated†. In a limb which Mr. Astley Cooper injected several weeks after the operation for popliteal aneurism, he was unable to force the injection through communicating vessels into the parts below; but in another limb in which the femoral artery had been obliterated a greater length of time, he was able to inject and display the numerous anastomoses by which the branches of the profunda communicated with the articular arteries of the knee‡. Pelletan dissected a limb twelve months after the ligature of the popliteal artery.

* A more particular account of these interesting dissections will be given when treating of inguinal aneurisms and the ligature of the external iliac artery.

† *Cases in Surgery*, p. 139, plate VII.

‡ *Medical and Chirurgical Transactions*, vol. ii. p. 249.

He traced several large communications between the superior articular and the recurrent branches of the tibial arteries, and observed numerous anastomoses between the minute ramifications of those vessels*.

From the facts which I have stated I think it is evident; 1st, that when the principal artery is tied in the middle of a limb, the circulation is immediately carried on through the innumerable anastomoses of minute ramifications; 2dly, that a few of these canals by degrees become more dilated than the rest; and, 3dly, that as these canals acquire a sufficient size for the transmission of a due quantity of blood for the support of the limb, the smaller anastomoses gradually subside to their original dimensions.

I have mentioned, that in the extremities the arterial trunks communicate with each other by large inosculations. By this arrangement those parts are in their natural state provided with a double circulation, so that when one trunk is obstructed, a sufficient quantity of blood is directly supplied by another without passing through minute anastomosing ramifications. There is an organ, the functions of which are so indispensable to the economy, that nature appears to have provided it also

* *Clinique Chirurgicale*, tom. i. p. 127.

with a double circulation, that its supply of blood may not suffer even a momentary interruption from the obstruction of one or more of its main arteries. The blood is distributed to the brain in such a manner as to guard against the effects of obstruction in one or more of its principal arteries. This arrangement is rendered more necessary from the slight degree of enlargement of which its arteries are capable, in consequence of their passage through bony canals. The transmission of the blood to the brain through four large arteries appears to effect this object, and to supply that organ with a larger quantity of this fluid than is indispensable for the due performance of its functions. It is an ascertained fact, that the vital functions are not in the least impaired by the obliteration of one or more of these channels, for the trunks inosculate with each other so freely within the skull, that one of the main arteries will readily supply the whole. If coarse injection be thrown into one carotid, it will not only fill all the arteries of the brain, but will pass down the opposite carotid and the vertebral into the aorta and subclavian arteries. Again, if the subclavian artery be injected, the wax will pass by the vertebral artery through the same communications not only into the opposite vertebral, but also into the carotid arteries. Physiologists have repeatedly tied both carotid arteries in brutes at the

same time, and yet the functions of the brain have not appeared to suffer the slightest interruption; and the common carotid has now been repeatedly tied with perfect success in the human subject for the cure of aneurisms. The branches by which the two carotid arteries anastomose with each other, and with the subclavian arteries, in some degree supply this deficiency by transmitting a stream of blood into the superior portion of the obliterated vessel. I have dissected a dog, both of whose carotid arteries had been tied several months before the animal was killed. The vertebral arteries appeared rather larger than natural. Branches which arose from the superior portion of the obliterated carotid arteries anastomosed freely with others that were given off by the vertebral, cervical, and subclavian arteries. The aggregate, however, of these anastomosing tubes was not equal to the calibre of one carotid artery in its natural state, and the difference appeared to be so great as to induce me to conceive that the brain could not be suddenly deprived of so considerable a portion of its supply of blood without disorder, unless in its natural state a larger quantity of that fluid is sent to it than is requisite for the due performance of its functions. I mention this opinion, however, with great reserve, because I have not hitherto been able to ascertain by experiment whether the

brain will be sufficiently supplied with blood through anastomosing channels, when its four trunks, namely, both the carotid and both the vertebral arteries, are tied at the same time.

The conspicuous anastomoses that are distributed around the joints probably constitute channels through which a collateral circulation is occasionally carried on even in the natural condition of the limb. The motions that are performed by the extremities must often place the main artery in an angular position, and thus afford great impediment to the passage of the blood through its cavity. Do not the large anastomoses that are distributed upon the sides of the principal articulations provide against obstruction from this circumstance? and does not the blood, when the limb is bent, pass chiefly through them instead of the main artery?

It is remarkable, that throughout the body the anastomosing branches of arteries are so distributed as to form arches which connect different portions of the same trunk, so that the blood may be conveyed from one extremity to the other of a vessel without passing through its cavity. Thus the anastomoses between the branches of the internal iliac and those of the profunda form a vascular arch, through which the blood may be conveyed into the thigh without passing through the external iliac artery: again, the branches of the profunda

communicate with branches which arise from the popliteal artery, so as to form an arch by which the blood may pass into the leg when a great portion of the femoral artery is obliterated. These larger communications are also in a similar manner connected with each other by smaller arches, forming an extensive arterial chain through which the circulation may be carried on when a great extent of the main artery is impervious. This arrangement exists throughout the whole system. In proportion as the vessels diminish in size, the more numerous are their communications with each other*.

The tortuous course which the anastomosing branches assume when a trunk is impervious, and the circulation of the part is carried on through them, is probably owing to their elongation in consequence of the increased impulse of the blood against their coats, so that they cannot be contained in the same space which they occupied in a natural state. If an artery in the dead subject be injected with considerable force, it generally becomes tortuous. The gradual distention of the coats of a blood vessel, as in most membraneous structures, is attended with an increased growth of the parts of

* The anastomosing branches of the principal arteries have been accurately described and most beautifully represented by SCARPA in his *Treatise on Aneurism.*

which they are composed, so that an anastomosing branch, instead of being rendered thinner by distention, acquires a sufficient degree of strength, from an accumulation of new matter, to enable it to perform all the functions of an artery.

The dilatation of the vessels by which a collateral circulation is carried on, takes place principally in the minute ramifications. The trunks of the branches from which these ramifications originate are very inconsiderably enlarged, even when a collateral circulation has been for a long time established. In several preparations which I have examined at different periods after the artery had been tied, the mouths of the branches above the place of obstruction in the main artery did not appear to be larger than in their natural state, and in a few instances only a slight dilatation was perceptible. It does not appear, therefore, to be through the mouths of the branches from which they arise that the minute ramifications derive the unusual influx of blood when the main artery is impervious, but from their extensive anastomoses with numerous arteries which originate from different sources *.

* An impelled fluid will of course pass more readily into those tubes in which it meets with the least resistance. Hence when the direct supply of an artery is obstructed, the blood will pass in greater quantity from other sources into its anastomosing branches which are empty, than into those

The anastomosing branches through which a collateral circulation is ultimately established, are by no means uniform in the limbs of different subjects. Thus a branch which in the thigh of one subject will be found to have afforded a considerable anastomosing ramification, in another will not have contributed in the least degree to the transmission of blood into the inferior trunks of the limb. Accidental circumstances may cause this variety. The pressure of an aneurismal sac in a particular direction, the position of the limb after an operation, and various other causes, may prevent the enlargement of a vessel which would probably, under other circumstances, have afforded a considerable communication.

Every part of the body appears to be endowed with the power of carrying on a collateral circulation, when the principal artery which passes through it is obliterated. If the descending aorta be rendered impervious, the branches which originate above, communicate so freely with those that are given off below the point of obstruction, that a collateral circulation is immediately established. Mr. Astley Cooper tied the aorta between the two

of vessels which are already filled. From this explanation it is evident that the anastomosing branches of an artery which are not filled by the trunk from which they arise, will derive an increased supply from all those vessels with which they communicate.

mesenteric arteries in several dogs. The animals survived the experiments, and appeared to suffer no inconvenience from the derangement in the course of the circulation. The blood was conveyed into the inferior portion of the aorta through numerous anastomoses between the lumbar arteries with each other, and the two mesenteric arteries, one of which originated above, and the other below, that portion of the vessel which had been obliterated by the ligature*. Scarpa has remarked, that if the aorta be tied in the dead subject immediately below its arch, and thin injection be thrown into the upper portion of the vessel, it will pass into the arteries of the lower extremities†. I have assisted in repeating this experiment upon a subject about four years of age. The aorta was tied above the cœliac artery, and water was injected into the ascending aorta through a pipe which was fixed into the origin of that vessel. The posterior tibial artery was then divided at the ancle: the water

* *Medical and Chirurgical Transactions*, vol. ii. p. 258. The aorta is without much difficulty exposed in small dogs by making an incision about three inches in length through the muscles of the back on the left side of the lumbar vertebræ. The peritoneum being turned aside by the finger, the aorta is distinctly felt pulsating. By means of a much curved aneurism needle, a ligature is easily passed around it.

† *Treatise on Aneurism*, WISHART'S *Translation*, p. 50.

issued from it in a considerable stream. The aorta was tied so tightly that its internal and middle coats were divided: none of the injected fluid could have passed through it in that situation. Several instances are recorded in which the calibre of the aorta was very much diminished, and even obliterated, in the living subject: the blood nevertheless found channels, through which it passed into the inferior parts of the body. "Stenzel found in the body of a man two steatomatous tumours, formed in the substance of the membranes of the aorta immediately below its arch, which almost entirely closed its tube, though this subject had always the habit of body of a well-nourished and robust man. Mekel in the bodies of two subjects found the aorta just below its arch so much thickened and constricted, that the blood impelled by the heart could pass with great difficulty and in small quantity, and regurgitated so strongly towards the heart, that it had lacerated the semilunar valves; notwithstanding which, there was no appearance in these subjects of the viscera of the abdomen or the inferior extremities having been deprived of the usual quantity of blood circulating in them*." Severinus gives an account

* Stenzel's case is related in his *Dissertatio de Steatomatibus Aortæ.* Mekel's is published in the *Mém. de l'Acad. R. de Berlin,*

of the dissection of an aneurism of the cœliac artery. The cavity of the aorta above the renal arteries was completely plugged up with a concretion*. Fantoni found in the cavity of the aorta, above its bifurcation and below a large aneurism, very dense polypous concretions, by which the passage of the blood into the iliac arteries was obstructed†. M. Paris injected the body of a woman about fifty years of age in whom the aorta a little beyond its curvature was contracted to the size of a common writing quill. The coats of the artery were of their natural thickness, and nothing could be found in the structure of the vessel, or in the condition of the surrounding parts, which could account for this remarkable constriction.

1756. Obs. xvii. xviii. Stoerk relates a similar observation, *Ann. Med.* ii. p. 171. This extract is taken from SCARPA'S *Treatise on Aneurism*, WISHART'S *Translation*, p. 49. I have not seen the original works.

* "Exorti igitur ab inferioribus, postquam ad arterias emulgentes pervenimus, superata jam parte qua magna arteria primos divaricatus sentit, corpuscula offendimus tria ex pituita concreta, sibimet ipsis incumbentia, quæ inturabili cujusdam modo arteriæ ductui sic offarcta transversim erant, ut spiritui se transfundenti præcluderent viam."— SEVERINUS, *de Reconditâ Naturâ Abscessuum*, p. 325.

† "Dissecto cadavere apparuit aneurisma arteriæ magnæ paulò supra iliacas, et infra locum aneurismatis aderant crassissimi polypi, qui sanguinis fluxum versus iliacas impediebant."— BONETUS; *Sepulchretum Anatomicum*, tom. iii. p. 556.

The aorta above the contracted portion was slightly dilated: below, it was of its natural size. The circulation was in part carried on through the contracted portion of the aorta, but a greater quantity of blood was sent by the heart through the mammary, cervical, thoracic, and scapular, into the intercostal, diaphragmatic, and epigastric arteries. All these vessels, as well as the arteria innominata and left subclavian artery, were remarkably dilated, and communicated with each other by very large anastomoses*. It has been fully proved that most of the primary branches of the aorta may be obliterated, and the parts which derive their vessels from those sources be amply supplied with blood. In a former part of this Treatise I have related an instance in which the subclavian artery was obliterated at its origin, and the arm was well nourished†. I have seen the cavity of the common iliac artery obliterated by a firm plug of lymph effused by inflammation‡; and the carotid, the external iliac, the brachial, and the femoral arteries, have been repeatedly and successfully tied for the cure of aneurisms and wounds.

The circulation which is effected through anastomosing branches is not only sufficient for the

* Desault, *Journal de Chirurgie*, tom. ii. p. 107.

† Case XIX. p. 111. ‡ Page 6.

nourishment of a limb, but is also capable of performing the offices of secretion. I had an opportunity of ascertaining this fact by witnessing the examination of a kidney, in which the cavity of the renal artery was obliterated by an accumulation of atheromatous and calcareous matter in its coats. The glandular structure was perfectly natural. The pelvis contained urine, and a considerable quantity of that fluid was found in the bladder. The kidney was supplied with blood by a large branch from one of the lumbar arteries, and by the arteries of the renal capsule. It is a curious circumstance, that the patient from whom this specimen was taken was afflicted with diabetes*. In Case XXIII† the mouths of the cœliac and superior mesenteric arteries were obliterated: the patient suffered no particular derangement in the functions of his alimentary canal: the liver and spleen were healthy.

The dilatation of the minute arteries does not appear to be entirely owing to the mechanical effect of the increased force with which the blood is driven into them when its passage through the main channel is obstructed. When an artery is tied after amputation, the end of the vessel,

* Bichat has remarked, that in diabetes the renal arteries are sometimes contracted.—*Anatomie Générale*, tom. ii. p. 373.

† Page 125.

although exposed to the impulse of the heart and arteries, does not become enlarged, nor are the branches given off by it above the ligature dilated. In the dissection of several stumps I have invariably found a considerable extent of the main artery, as well as the branches arising from it, remarkably contracted*. The permanent enlargement of the collateral branches seems to be dependant upon a property in the vascular system whereby the size of the vessels is always accommodated to that of the part which they supply. Thus in enlargements of joints, or of viscera, as the liver or spleen, and

* Warner relates a case in which a series of aneurisms formed in the extremity of a brachial artery which had been tied in amputation. The following are the particulars of this remarkable case. The arm of a man was amputated in consequence of a disease in the elbow. The arteries were secured by a needle and ligature. A few days after the operation the extremity of the brachial artery was so much dilated as to endanger its bursting. The operation for aneurism was therefore performed, and the artery was tied above the upper extremity of its distended coats. The patient appeared to be doing well for some time, when suddenly another aneurism appeared above the second ligature. The disease increased so rapidly that it was necessary to repeat the operation. Every thing went on favourably until the stump was nearly healed, when a third aneurism appeared in the extremity of the artery. Another operation was accordingly performed. The brachial artery was tied near the axilla, and the patient was permanently cured. — WARNER'S *Cases in Surgery*, p. 139. Ruysch

in sarcomatous tumours, the arteries by which they are supported become exceedingly enlarged, so that in the removal of adventitious growths it is necessary to tie many vessels which in a healthy state of the parts are not apparent. Now when a main artery is obliterated, the whole limb is dependant for its supply of blood upon the collateral branches, and may be regarded as an adventitious appendage which derives its nourishment entirely from them. These branches are consequently enlarged to transmit a due quantity of blood in the same manner as they are dilated for the support of morbid growths.

The unusual influx of blood into the minute

relates an observation in some respects similar to the above. He tied both extremities of the vessel in an aneurism arising from a wound of the brachial artery at the bend of the arm. A piece of leather was interposed between the artery and the ligatures, which were removed on the third and fourth days, without being allowed to separate spontaneously. The wound was filled with dressings. On the seventh day a slight hæmorrhage occurred: both extremities of the artery were seen at the bottom of the wound. About the tenth day they were concealed by granulations. Shortly afterwards they again appeared dilated into two aneurisms. One of these tumours burst. It was larger than a pea. The hæmorrhage which ensued was restrained by pressure. By the employment of bleeding, a slender diet, and compression, this tumour disappeared. The other aneurism continued some days longer. At length it subsided, and the patient recovered.—RUYSCHII *Opera; Obs. Anatomico Chirurgicæ*, tom. i, p. 4.

ramifications when a main artery is suddenly rendered impervious, is generally attended with a remarkable increase in the temperature of the limb. In most instances, immediately after the operation for aneurism the temperature of the diseased limb is below that of the rest of the body. In the course of a few hours it increases, and on the second and third days it is four or five degrees higher than the temperature of the opposite limb. It continues in this state for several days, during which time the anastomosing channels are dilated: it then gradually subsides, and the limb becomes of the same temperature as the other parts of the body. This fact has been noticed by several writers. Sir Everard Home has mentioned, that after most of the operations for popliteal aneurism which were performed by Mr. Hunter, the temperature of the diseased was higher than that of the sound limb for several days *. Scarpa also observed the same circumstance in six cases after the ligature of the femoral and brachial arteries †. Mr. Forster measured the variations in the temperature of a limb after the ligature of the femoral artery for a popliteal aneurism. On the day following the operation, the temperature of the ham in which

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 159, 162, 165.

† *Treatise on Aneurism*, WISHART'S *Translation*, p. 405, 424, 428, 431, 436, 438.

the aneurism was situated was a few degrees lower than that of the opposite limb. On the second day it was three degrees higher than in the sound ham, and from the third to the sixth day the disproportion in the temperature of the two limbs was from three to five degrees. The heat of the diseased limb gradually decreased, and at the end of three weeks the temperature of both limbs was the same*. I have had opportunities of remarking the increased temperature of several limbs in which the femoral artery had been tied for the cure of aneurisms. During the first week the heat was generally from five to eight degrees higher in the sound than in the diseased limb: in the second week it gradually decreased: at the end of the third week no difference could be ascertained in the temperature of both extremities. An increase in the temperature of the limb does not however always take place after the operation for aneurism. In one instance in which I had an opportunity of attending to this point, not the slightest variation could be ascertained between the heat of the sound limb and of that in which the femoral artery had been tied†. This circumstance

* *Medical Facts and Observations*, vol. v. p. 11.

† In a second case related by Mr. Forster, the temperature of the limb in which the femoral artery had been tied was less than that of the opposite extremity. See ibid. p. 16. After one of Mr. Hunter's operations, "the heat of the two legs was

may be explained by the probability of a collateral circulation having already been established, in consequence of the obstruction which was offered to the passage of the blood through the main artery by the accumulation of coagulum in the aneurismal sac. The increased temperature of a limb after the principal artery is tied appears to arise from the unusual influx of blood into the minute arteries. The part in which the anastomosing vessels are situated may be said to be in a state of inflammation, which is always attended with an unusual evolution of heat. The condition of a limb in which the main artery has been tied affords an illustration upon a large scale of that theory of inflammation which was founded upon the supposi-

carefully examined twice a day, from the second to the ninth after the operation, and the limb operated upon was uniformly colder than the other." *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 164.—The increase of temperature which has been observed after the operation for aneurism, cannot have arisen solely from the application of warm clothing, for in one of Mr. Forster's cases, in which the examination appears to have been conducted with great accuracy, the heat of the diseased was several degrees below that of the sound limb, although the part, as well as the bulb of the thermometer, was surrounded with flannel. The heat should be measured at that part of the limb in which the principal anastomosing branches are situated. Thus when the femoral artery is tied, the thermometer should be applied to the posterior part of the thigh, and the vicinity of the knee.

tion of an *error loci* in the larger globules of the blood*.

There are several circumstances in the condition of the limb, the coats of the arteries, or the system in general, which may prevent the establishment of a collateral circulation. An extensive transverse wound, by which the principal anastomosing branches are divided, or the application of tight bandages, may obliterate the channels through which the circulation would otherwise be carried on. If a limb after the operation be placed in such a position that the chief weight of it rests upon that part in which the principal collateral branches are situated, their dilatation may be obstructed: hence such positions as well as circular bandages should be avoided after the operation for aneurism. When an aneurism has acquired an immense bulk, it has probably destroyed the parts in which some of the principal anastomosing branches are situated, or by its pressure may prevent their dilatation. This circumstance constitutes an additional argument against permitting an aneurism to acquire a large size before an operation is performed. An extensive deposition of calca-

* Boerhaave conceived that the vessels were of different sizes for the circulation of blood, lymph, and serum; and that when the larger sized globules passed into the smaller vessels by an *error loci*, an obstruction took place which gave rise to all the phenomena of inflammation.

reous matter in the coats of arteries renders them incapable of dilatation. It is a well known fact that the deposition of calcareous matter more frequently takes place in the arteries of old persons, than at an earlier period of life. It is probably owing to this circumstance that mortification of the limb more frequently follows the operation for aneurism in old than in young subjects. In advanced life the elastic property of the arteries is diminished, and many of their minute ramifications appear to have become obliterated. I have already noticed the difference which has been observed in the vascularity of the limbs of old and young persons*. Anatomists know that to succeed in a minute injection it is necessary to choose a young or middle aged subject. Not only are the arteries more numerous and more capable of distention, but the power of the heart is greater at an earlier period of existence. These circumstances render the establishment of a collateral circulation more precarious in an old than in a middle aged patient.

A languid state of the circulation is adverse to the enlargement of the anastomosing branches, and insufficient for the support of a limb which derives its blood through collateral channels. In constitutions debilitated by continued disease, the

* See page 24.

operation for aneurism is therefore sometimes unsuccessful. A vigorous circulation is necessary for the establishment of a collateral circulation: hence the impropriety of copious bleedings after the operation for aneurism. I am informed by my friend Mr. George Young, that soon after the modern operation was introduced at Paris, it was the custom to employ repeated venesections, and that mortification of the limb was a frequent occurrence. Mortification of the extremities has been regarded by some authors as the effect of a languid state of the circulation, in consequence of an impediment to the transmission of blood through the main arteries. Hildanus*, Lancisi†, and Senac‡, have endeavoured in this manner to explain the coexistence of mortification of the extremities with aneurisms of the heart and large arteries. Corvissart‖ mentions two cases in which obstruction in the passage of the blood through the heart was attended with sphacelation of the arm. Mortification of the feet in old persons in whom the passage of the blood through the main arteries is prevented by a deposition of calcareous matter, probably arises from the feeble state of the circulation in the extremity of the

* *Opera*, cent. ii. obs. 49.

† *De Motu Cordis et Aneurismatibus.*

‡ *Traité de la Structure du Cœur*, tom. ii. p. 415.

‖ *Essai sur les Maladies du Cœur*, p. 177.

limb*. In the subject of the following case, who is at this time under the care of Mr. George Young, mortification of the hand appears to be the consequence of the pressure of a tumour upon the subclavian artery and its principal branches.

CASE XXXVIII.

A THIN man, about fifty-five years of age, had complained of deficient sensation in the left arm and hand for nearly two years, when he applied for surgical assistance in consequence of the formation of two black eschars upon the knuckles after a slight abrasion of the skin. The extremity of the little finger was also black, and the nail appeared as if it had been violently pinched, although no accident had occurred to it. These sloughs were not surrounded by a line of separation. They were attended with extreme pain, swelling, and a burning sensation in the arm and hand. The temperature of the limb was considerably below that of the opposite extremity. Pulsation could not be felt in the radial, ulnar, brachial, axillary, or subclavian arteries. A hard compact tumour, about the size of an egg, was discovered above the clavicle. It was firmly attached to the first rib, from which it probably originated, and compressed the subclavian artery and its principal

* See page 41.

branches. It was attended with so little inconvenience that the patient was not aware of its existence until it was pointed out to him. Friction and warm clothing were applied to the arm, and poultices to the sloughs. His general health was good, but the extreme pain in his hand could only be allayed by large doses of opium. It was some time before the sloughs separated, and the sores were very tardy in healing. The last phalanx of the little finger sloughed off. It is now five months since the eschars formed upon the knuckles. The sores are healed. The limb has regained its natural heat and sensation. No pulsation can, however, be felt in any of its arteries. The tumour above the clavicle is in the same state as when first observed.

In this case it appears probable that the subclavian artery, and some of its branches which pass over the root of the neck, have been obliterated by the tumour above the clavicle, and that the collateral circulation was at first too languid to support the extreme parts of the limb. As the circulation became more fully established, the heat and sensation returned, and the sphacelation ceased. In a case which I have related*, mortification of the limb followed the ligature of the external iliac artery. The trunk of the internal iliac

* Case XXXV. p. 198.

artery in this subject was unusually small, and it was probably owing to this circumstance that a sufficient quantity of blood did not pass into the limb for its support.

The abstraction of heat from a limb after the operation for aneurism has been known to produce mortification*. On the other hand, the application of artificial heat has been avoided, from a dread of its proving injurious, by exciting undue action in the vascular system of the part†. There does not in most instances appear to be any direct indications for increasing or diminishing the heat of a limb after the operation for aneurism. If the action of the arteries be torpid, it may be proper to quicken it by friction or warm clothing: if it be excessive, it may be con-

* Mr. Astley Cooper has mentioned a case in which the application of a solution of acetate of lead on the evening after an operation for popliteal aneurism was followed by the mortification of the limb. In another case the operation was performed at a time of the year when the weather was extremely cold. In three nights after the operation the patient said his foot was benumbed, and when it was examined it was found to be of a blue colour, and quite cold. Frictions were immediately had recourse to; first with the hand only, and after a time with warm flannels: the circulation was restored, although with considerable difficulty.—*Medical and Chirurgical Transactions*, vol. ii. p. 252.

† ABERNETHY, *Surgical Observations, on Aneurisms*, p. 140. Second edition.

trolled by general bleeding, and the employment of evaporating washes.

I have seen two instances in which the limb mortified after the ligature of its principal artery. The part at which the living was connected with the dead flesh exhibited the usual appearances of gangrene. The remainder of the dead parts had not undergone those peculiar changes which take place when gangrene is the consequence of inflammation. They had the appearance of parts which have remained a long time in a dissecting room. They were of a pale colour, and soon became putrid. The cuticle peeled off, and was followed by an oozing of filthy sanies. I have, however, heard of instances in which the whole limb became black, and presented the appearances which are peculiar to gangrene.

A knowledge of the ample provision that exists in every part of the system by which a collateral circulation may be carried on, and of the manner in which this object is effected, gives rise to several important practical conclusions.

First: When the circumstances tending to prevent the establishment of a collateral circulation, which I have mentioned, do not exist, we need not apprehend the death of any part in consequence of a deficient supply of blood after the ligature of its main artery.

Secondly: The circulation will be as effectually

carried on in a healthy limb when the main artery is suddenly tied in consequence of a wound, as when an aneurism has existed for a considerable time.

Lastly: The practice of permitting an aneurism to increase, that the collateral branches may become enlarged, is not only unnecessary, but injurious, inasmuch as that the increase of the tumour must be attended with a destruction of the surrounding parts, which will render the cure of the disease more tedious and uncertain.

THIRDLY. I shall consider the effects produced upon an aneurism by the ligature of the superior part of the artery from which the disease originates.

When the artery is tied close to an aneurismal sac, the ingress of blood into the latter is in most instances entirely prevented: the coagulum which it contains is absorbed, and the membranes of which the sac is composed gradually contract until its cavity is permanently obliterated. But when the artery is tied at a distance from the disease, the ingress of blood into the latter is not altogether prevented, for the anastomosing branches which open into the trunk below the seat of the ligature convey a stream which passes through the aneurism. The impulse of this current is, however, so trifling, that the enlargement of the sac not only

ceases, but the deposition of coagulum in it increases in consequence of the languid state of the circulation. The coagulum accumulates until the cavity of the sac and the mouth of the artery leading into it are obliterated. By the absorption of the coagulum, and the contraction of the sac, the cure is ultimately accomplished, in the same manner as when the artery is tied close to the tumour, or the disease is remedied by the spontaneous efforts of nature.

That a stream of blood in most instances passes through the sac after the ligature of the superior part of the artery at a distance from the disease, is confirmed by numerous observations, and is a fact of great importance, both in a practical and pathological point of view. It is proved, 1st, by the occasional recurrence of pulsation in the tumour after the operation: 2dly, by cases in which the cavity of the sac has been exposed, and hæmorrhage has been the consequence: and, 3dly, by dissections, in which it has been found that the cavity of the aneurism as well as that of the artery from which it originated, was pervious, from the part which was obliterated by the direct operation of the ligature.

The recurrence of pulsation in the aneurism a few hours after the operation, has been noticed in several instances. Sir Everard Home mentions

three cases *, and I shall hereafter have occasion to refer to others in which it took place. The facts which I shall relate prove that it arose from the transmission of blood into the sac through anastomosing branches. In the following case the pulsation in the aneurism recurred after the operation, and continued until the second day. On the thirty-ninth day a communication was formed by ulceration between the cavity of the sac and that of an abscess which had burst externally: profuse hæmorrhages were the consequence.

CASE XXXIX.

A ROBUST man, twenty-nine years of age, imputed the commencement of an aneurism in his ham to a violent blow against the pole of a carriage. A swelling, accompanied with excessive pain, immediately arose. The leg was cold and benumbed, and he experienced frequent shiverings. He continued in this state three weeks, when he applied for surgical relief. The tumour in the ham was circumscribed, and about the size of an egg. It was attended with an evident pulsation. The femoral artery was tied in the middle of the thigh.

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 173, and vol. ii. p. 239, 253.

For several days the patient went on well. The temperature of the diseased, exceeded that of the sound limb. There was an evident pulsation in the tumour; not, however, equal in force to that of the radial artery. On the second day after the operation the pulsation in the aneurism was imperceptible. On the fourteenth day, when an attempt was made to bring away the ligature, a considerable hæmorrhage took place from the wound. It was suppressed by the application of a tourniquet. The ligature came away on the twenty-sixth day after the operation. On the thirty-third day an abscess unexpectedly burst in the ham. He had never complained of pain in that situation so as to excite any degree of attention. During the first day a pint of matter was discharged, and on the sixth day after this occurrence a profuse hæmorrhage took place from the abscess. The bleeding recurred thrice on the seventh day, and could not be restrained by the application of a tourniquet. Pressure on the part alone checked it. The hæmorrhage returned again and again until the eighteenth day after the bursting of the abscess, when the life of the patient was exhausted.†

Upon dissection, the femoral artery was found to be completely obliterated at the place where the ligature was applied. The canal of the artery was

† Why was the ligature not substituted before that time?

pervious from that part to its entrance into the sac in the ham. The sac had ulcerated, and burst into the surrounding parts, in which there was a collection of matter extending from the condyles of the femur to the termination of the belly of the gastrocnemius muscle. The artery, beyond the aneurism, was remarkably contracted. The blood had proceeded from the sac, into which it had passed through anastomosing branches.

The femoral artery was tied in a middle-aged man a little below the origin of the profunda. The aneurism in the ham sloughed after the operation, and burst on the tenth day. Profuse hæmorrhage from the sac was the immediate consequence, and the condition of the parts rendered amputation necessary. The femoral artery was pervious from the part at which it had been amputated to the sac in the ham. Several anastomosing branches, which were also pervious, opened into its cavity in that space. The lower extremity of the popliteal artery was filled with a firm plug of coagulum*. In another case in which the thigh was amputated after the operation for popliteal aneurism, the blood gushed in a considerable stream from the femoral artery, which was divided below the part at which the ligature had been applied. In this

* This case was communicated to me by Mr. Astley Cooper.

case the aneurism increased after the ligature of the superior portion of the artery, and burst into the cellular membrane around the knee. The artery was pervious at its entrance into the sac. Mr. Astley Cooper injected and dissected a limb ten weeks and six days after the ligature of the external iliac artery. Five aneurisms existed in this extremity; namely, one in the groin, a larger one in the thigh, and three smaller ones in the ham. Mr. Cooper was able to force injection into the femoral artery above the aneurisms through the anastomoses of the branches of the internal iliac, with those of the profunda, epigastric, and external pudendal arteries. There can be no doubt, therefore, that the blood had passed into the femoral artery and the aneurisms, after the obliteration of the external iliac artery. The tumours in the groin and the thigh diminished after the operation, and the processes by which their ultimate cure would have been accomplished, if the patient had not been destroyed by another cause, had commenced*. Chopart dissected a limb in which he had performed the modern operation for popliteal aneurism. The femoral artery was obliterated to the extent of the breadth of three fingers at the part where the ligature had been

* *Medico-Chirurgical Transactions*, vol. iv. p. 427.

applied. Below this obliterated portion its calibre was of the natural size. The aneurism in the ham contained a large quantity of coagulum. The openings of both extremities of the artery in the sac were very apparent. The upper was almost closed by the coagulum *.

These facts, which derive additional illustration from several cases which will be mentioned hereafter, and from a knowledge of the origin and connexion of the principal anastomosing branches, prove that a stream of blood passes through the aneurism after the ligature of the artery at a distance from the disease. This is not, however, a permanent occurrence, for the ingress of blood into the tumour is gradually obstructed by the accumulation of coagulum, with which the sac is filled, and the mouth of the artery from which it originates is closed. The coagulum is absorbed, and the sac and the artery contract until the cavity of the latter is obliterated, both above and below the part from which the aneurism arose, to the origin of some important branch. In the dissection of cases some time after the operation, it has been found that the cavity of the sac was filled with concentric layers of coagulum, similar to that which is met with in aneurisms undergoing spontaneous

* Deschamps, *Obs. sur la Ligature des Artères*, &c. p. 56.

cures. In Chopart's case the accumulation of coagulum had almost filled the sac*. Fifteen months after the operation, Mr. Hunter found a solid coagulum of blood which adhered to the internal surface of the sac. A section of this coagulum appeared to be composed of concentric lamellæ, uniform in colour and consistence†. In a similar case Deschamps found the sac filled with a firm mass of coagulum without any fluid blood in its centre‡.

As the absorption of the coagulum advances, the membranes of which the sac is composed gradually contract, and are ultimately converted into a solid ligamentous cord or knot, similar to that which is met with at a remote period after a spontaneous cure‖. Eight years after the operation Deschamps found the tumour in the ham reduced to the size of a small olive, and composed of a solid ligamentous substance§. I have seen a preparation taken from a patient seven years after the operation, at which time the only vestige of the disease in the ham was a

* Deschamps, *Obs. sur la Ligature des Artères*, &c. p. 56.

† *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 154.

‡ *Obs. sur la Ligature des Artères*, &c. p. 59. ‖ See p. 116.

§ *Mémoires presentées à l'Institut des Sciences*, &c. tom. i. p. 251. An. 1805.—See Scarpa, *Treatise on Aneurism*, Wishart's *Translation*, p. 465.

ligamentous band, connecting the obliterated extremities of the artery. In the dissection of a similar case, Mr. Astley Cooper found the disease in the ham and the femoral and popliteal arteries, from the origin of the profunda to the commencement of the tibials, converted into a solid cord*.

Although it is evident from the preceding observations, and from a knowledge of the origin of the principal anastomosing branches, that a stream of blood in most instances passes through the aneurism after the ligature of the superior part of the artery, yet this current is in most instances not sufficient, either by its quantity, or by the force with which it is impelled, to continue the disease. On the contrary, the deposition of coagulum is promoted by the languid state of the circulation; and when the accumulation has proceeded to a sufficient extent to oppose a resistance to the transmission of blood through the sac, that fluid passes more readily through anastomosing branches into the inferior trunks of the limb, than through the main artery and the tumour. It consequently deserts the old channel, according to that principle which so materially influences the establishment of a collateral circulation, namely, that an impelled fluid passes more readily into those tubes in which it meets with the least resistance. In proportion to

* *Medico-Chirurgical Transactions*, vol. ii. p. 254. plate VI.

the diminution of the stream, the main artery contracts, and its cavity is finally obliterated when the blood is precluded from entering the aneurism. The gradual contraction of the artery takes place according to that law by which the calibre of a vessel always becomes adapted to the size of the stream which passes through it. Thus the arteries of the breast and womb which are dilated during pregnancy, gradually contract when their supply of blood is diminished: and the ductus arteriosus and hypogastric arteries are obliterated after birth, when the blood passes through other channels. "Supported by these facts, it may be established as a theorem in physiology, that whenever the blood meets with a powerful obstruction in its passage to a given place through an artery, it leaves that artery to enter into another, and the artery which has been abandoned diminishes gradually in diameter until it is entirely obliterated*."

The gradual contraction of the artery, in consequence of the diminution of the stream which it receives, has been noticed in several dissections, after the operation for popliteal aneurism. Vacca mentions, that, fifty-two days after the operation, he found "the femoral artery below the ligature gradually diminished in diameter, in propor-

* Scarpa, *Treatise on Aneurism*, Wishart's *Translation*, p. 213.

tion as it proceeded downwards from the wound, or the place of the ligature, so that it was nearly obliterated some lines above, where it loses the name of popliteal, and divides into the tibial arteries. At this point the two sides of the popliteal artery were become much thicker than usual, and presented a very small aperture, from which there was an opening into a membraneous sac, the parietes of which had almost every where approached and adhered together*." Deschamps dissected the body of a man who died in consequence of extensive suppurations in the thigh after the femoral artery had been tied with a *presse-artère*. The artery was found to be considerably diminished in diameter below the part which had been tied. The aneurismal sac in the ham was likewise very much diminished in bulk, and contained a firm mass of coagulum†. A patient upon whom Scarpa operated died in consequence of the rupture and sphacelation of an immense popliteal aneurism, upwards of forty days after the ligature of the femoral artery. From the place of the ligature downwards, the artery was contracted in diameter, and irregularly obliterated: for three inches and a half below the ligature it was quite impervious, so that it was impossible to pass

* SCARPA, *Treatise on Aneurism*, WISHART'S *Translation*, p. 251.

† *Observations sur la Ligature des Artères*, &c. p. 59.

along it one of the finest probes. From thence downwards it was likewise contracted, but pervious for some space: it was then closed up anew in the vicinity of the ham, where it was all confusion, caries, and corruption *,

In the preparations that I have examined, and in all the cases that I have met with upon record in which the parts were dissected after a complete and radical cure of aneurism was effected in consequence of the modern operation, the cavity of the sac has been found obliterated, and the only vestige of the disease which remained was a solid ligamentous substance. Both extremities of the artery from which the aneurism arose were also obliterated to the origin of some important branch. In Mr. Astley Cooper's case the femoral artery was converted into a solid cord, from the origin of the profunda to the commencement of the tibial arteries †. This, however, is the only instance with which I am acquainted where so extensive an obliteration of the artery had taken place. In all the other dissections after the modern operation for popliteal aneurism that I know of, the femoral artery has been found to be obliterated for the space of three or four fingers' breadth at the place where the ligature was applied: below that part it was pervious, and continued so for

* *Treatise on Aneurism*, WISHART's *Translation*, p. 411.

† *Medico-Chirurgical Transactions*, vol. ii. p. 254. plate VI.

some distance, when the obliteration again commenced, and continued throughout a considerable extent of the popliteal, to the origin of the inferior articular or tibial arteries. Thus, as it were, an insulated portion of the femoral artery preserved its cavity, which was terminated above by the part which had been obliterated by the ligature, and below by the part which had become impervious in consequence of the effects of the operation upon the aneurism in the ham. From each extremity of this insulated portion of artery which still preserved its calibre, considerable anastomosing branches arose: the upper branches conveyed blood into the vessel, and the lower transmitted it into anastomosing channels that originated below the knee. A double collateral circulation therefore existed in the limb, namely, one by which blood was conveyed from the branches of the profunda into the femoral artery, which was pervious below the part obliterated by the ligature, and a second by which it was forwarded from this insulated portion of vessel into the trunks of the leg through the articular arteries of the knee.

I have seen a preparation in the possession of Mr. Headington, which was taken from a man who died seven years after an operation for popliteal aneurism,

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 154.

in consequence of the bursting of an aneurism of the aorta. The femoral artery was pervious from the part which had been obliterated by the ligature to the popliteal artery, where the obliteration again commenced. Mr. Brodie informs me, that he met with a similar condition of the vessels in a limb which he dissected at a distant period after the cure of a popliteal aneurism by the modern operation. Mr. Forster has a drawing in his possession taken from a case of popliteal aneurism, in which the femoral artery was tied below the origin of the profunda by Mr. Astley Cooper in August: the man died in January following. When the limb was injected, the femoral artery below the part obliterated by the ligature was found to have received a part of the injection through branches which anastomosed with the profunda, but it was impervious where the aneurism was situated. The injection had passed out of this insulated portion of the femoral artery into branches which communicated with the inferior articular arteries of the knee*. In Mr. Hunter's first patient, who died fifteen months after the operation, " the femoral artery was impervious, from its giving off the arteria profunda as low as the part included in the ligature. Below this part the femoral artery was pervious

* Mr. Cooper has mentioned this case in the *Medico-Chirurgical Transactions*, vol. ii. p. 253. I am indebted to Mr. Forster for an inspection of the drawing.

down to the aneurismal sac, and contained blood, but did not communicate with the sac itself, having become impervious just at the entrance*." Deschamps dissected the body of a man in whom he had tied the femoral artery for a popliteal aneurism. This operation completely succeeded, and the patient was able to resume his employment as a coachman. He died of a pulmonary complaint nearly eight years after the cure of the aneurism. The middle of the femoral artery, where the ligature had been applied, was obliterated for the space of two inches and a half, and converted into a shapeless ligamentous mass. Below this obliterated portion the vessel preserved its natural diameter as far as the popliteal artery, where the aneurism had been situated. Here the obliteration again commenced. The tumour was reduced to the size of a very small olive: it appeared to be formed of a solid ligamentous substance: the popliteal artery at that place was obliterated for the space of an inch and seven lines. Several anastomosing branches arose from that portion of the femoral artery which was situated between the two points of obliteration; and the limb having been injected, and accurately dissected, the distribution of the arteries clearly proved that a

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 153.

double collateral circulation had existed. Immediately below the part obliterated by the ligature, two branches came off from the femoral artery: the first passed externally, and anastomosed with three branches which arose from the femoral artery immediately above its obliteration, and with a branch of the external circumflex: the second passed internally, and anastomosed with a branch of the profunda, and with a twig of the inferior branch of the external circumflex artery. Above the inferior obliteration which was situated in the ham, the external articular, and several internal articular arteries of considerable size, came off, among which a large branch descended on the inner side of the knee, and joined the popliteal below the tumour, before its division into the tibial and peroneal arteries. The other superior articular arteries, both internal and external, communicated, by means of very numerous anastomoses, with the inferior articular arteries, which, by several ramifications, but principally by two trunks much enlarged in diameter, communicated with the popliteal artery below the obliteration. Independant of these communications, some of the branches of the profunda anastomosed with those of the articular arteries, so that all the blood was not transmitted into the inferior trunks of the limb through the medium of that insulated portion of the femoral artery which still preserved its calibre,

From the dissection of this case M. Deschamps formed the following conclusions, which I am induced to insert, because they corroborate in many respects the account which I have given of the effects produced upon an aneurism by the ligature of the artery at a distance from the disease. "1. That the course of the blood in this subject was only interrupted in the femoral artery for the space of two inches and a half: that below the obstruction the arterial canal resumed its natural diameter: that the blood was conveyed into it by two enlarged collateral branches. 2. That the blood which passed into the femoral artery below the obstruction, passing from a small into a large canal, lost its impulsive motion: that this blood circulating slowly in the femoral artery, had no longer any action either upon the aneurismal sac, which necessarily, from the first instance, ceased to increase in bulk, nor upon the mass of blood contained in it, which then, being left at rest, of necessity coagulated. 3. That the blood continued to circulate through the superior articular into the inferior articular arteries, to pass into the popliteal artery below the aneurismal sac. 4. That the constriction of the femoral artery had stopped for a short time, but did not interrupt the circulation in the part below the sac. 5. That it is not so much to the quantity of blood which reaches the tumour that it owes its enlargement, as

to the impulse which the sac receives from the column of blood which strikes it every instant*."

In some of the cases that I have mentioned, the parts were examined seven or eight years after the operation, and the artery was found to preserve its calibre between the part which was obliterated by the ligature, and that in which the aneurism had existed. From the length of time which had elapsed, it is probable therefore that no further obliteration of the artery would have taken place, and that had the life of the patients been prolonged, this peculiar arrangement by which the circulation was carried on would have continued. The only instance that I have met with in which after the modern operation for popliteal aneurism, the artery was obliterated from the seat of the disease in the ham to the part at which the ligature had been applied, is that recorded by Mr. Astley Cooper†; whereas in five cases that I have mentioned, in which the limbs were dissected at distant periods after the operation, the femoral artery remained pervious between the part obliterated by the ligature, and that in which the aneurism had existed. From this circumstance it appears probable that in most instances a double

* *Mémoires presentées à l'Institut des Sciences*, &c. tom. i. p. 251. An. 1805.—See Scarpa, *Treatise on Aneurism*, Wishart's *Translation*, p. 465.

† *Medico-Chirurgical Transactions*, vol. ii. p. 254. plate vi.

collateral circulation exists in the limb, after the cure of popliteal aneurism by the ligature of the femoral artery at a distance from the disease.

The preceding observations, however, merely prove, that in general the artery continues pervious between the part obliterated by the ligature and that in which the disease was situated, when the cure of a popliteal aneurism has been effected by the modern operation. The origin and connexion of the principal anastomosing branches render it very probable that in other parts of the body a similar arrangement prevails when an aneurism is cured by the ligature of the artery at a distance from the disease. Mr. Astley Cooper has published an account of the dissection of a case in which the external iliac artery was tied for the cure of an aneurism arising from the femoral artery below the origin of the profunda. The patient survived the operation nearly three years. The external iliac artery was obliterated. About an inch of the femoral artery just below Paupart's ligament still remained pervious, but below this part it had become simply a ligamentous cord. The blood had passed into this small portion of the femoral artery through the epigastric, which derived its supply from the obturatrix*, and from a

* In this subject, the obturatrix arose from the epigastric, and anastomosed freely with the internal pudendal and the internal circumflex arteries.

large branch which communicated with the internal iliac artery. The profunda originated from the inferior part of that small extent of the femoral artery which was pervious; so that the blood which entered the latter from the epigastric was transmitted through the profunda into the inferior trunks of the limb*.

I have already mentioned that a pulsation sometimes returns in the aneurism after the modern operation. This secondary pulsation, however, generally ceases in the course of a few days, when the coagulum within the sac has accumulated to a sufficient extent to resist the impulse of the circulating blood. A few rare instances have been recorded in which the tumour is said to have increased after the operation, and the existence of a secondary aneurism was the consequence. Mr. Pott adopted Mr. Hunter's mode of operating in a case of popliteal aneurism. He "began the operation by making an incision, about five inches in length, upon the posterior part of the thigh, through the common integuments, a little higher than the tumour, and in the direction of the thigh between the two hamstrings: he then dissected down to the vessels at the upper end of the incision, which being there deep-seated, proved both tedious and difficult. Having come to the vessels, a double ligature was passed, and

* *Medico-Chirurgical Transactions*, vol. iv. p. 429. plate v.

the two portions tied separately, at nearly half an inch distance. The depth of the incision made it difficult for any but the operator, and those immediately assisting him, to see what was included in the ligature, and at the time the popliteal artery was supposed to be secured by it. The wound was dressed in the common way. The second day after the operation, a pulsation was felt in the tumour, which afterwards enlarged so much, that Mr. Pott amputated the limb *." After a similar operation which M. Guèrin performed, the patient was destroyed on the fourth night by a sudden hæmorrhage from that part of the artery where the ligature was applied. When the limb was dissected, the aneurism was found to be much larger than before the operation †. Although these cases are involved in great obscurity, and it is doubtful whether in either of them the artery was included in the ligature, yet the instances which I have related where the sac burst after the operation, and profuse hæmorrhage ensued ‡, render it very desirable to ascertain what treatment should be adopted in the event of such occurrences, or the existence of a secondary aneurism.

The blood which enters the sac after the ligature of the artery at a distance from the disease, may be

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 172.

† *Journal de la Société de Santé de Paris*, No. iii. p. 197.

‡ Page 270.

derived from three sources. 1st. It may enter the aneurism from the superior extremity of the artery into which it was transmitted, through anastomosing branches opening into the trunk between the sac and the part at which the ligature was applied. 2dly. It may pass into the tumour in a retrograde course through the inferior extremity of the vessel: and, 3dly. It may be conveyed through anastomosing branches which open into the sac itself.

In a case which I have mentioned *, the aneurism increased and burst after the operation: when the limb was amputated, the blood gushed from the femoral artery, which was divided below the seat of the ligature, in a considerable stream. The blood, therefore, entered the sac after the operation through the superior extremity of the artery. In a case in which Mr. Astley Cooper tied the carotid artery, a pulsation was perceptible in the aneurism more than two months after the operation, when it gradually ceased †. From the situation of the tumour, it is probable that the aneurism arose from the carotid artery at its bifurcation, in which case the blood must have passed into the sac either through that extremity of the artery which is situated at the greater distance from the heart, and which is analogous to the inferior portion of the vessel in the limbs, or through anastomosing

* Page 270.

† *Medico-Chirurgical Transactions*, vol. i. p. 222.

branches which opened into the sac itself. In a case, of which I have related a brief outline*, the aneurism in the ham sloughed after the ligature of the femoral artery: profuse hæmorrhage ensued. When the limb was amputated, the lower extremity of the artery, which had communicated with the sac, was found to be filled with a firm plug of coagulum. The blood, therefore, must have entered the sac either through the superior portion of the vessel, or through anastomosing branches which opened into the aneurism. In Case XXXIX †, the pressure of a tourniquet upon the femoral artery did not arrest the hæmorrhage from the sac in the ham, which had been exposed by ulceration. In this instance the blood must have passed either from the inferior extremity of the vessel, or from branches which opened directly into the sac.

If the pulsation in a secondary aneurism cease upon compressing the artery a little above the tumour, a surgeon would be justified in tying the superior part of the artery as near as possible to the sac. In the same manner, if the flow of blood into the aneurism was arrested by compressing the inferior portion of the vessel, he would be justified in tying the artery below the tumour. In most instances, however, it will be extremely difficult to ascertain from which of the sources that

* Page 270. † Page 268.

I have mentioned the blood passes into the sac, and the surgeon will be reduced to the alternatives of performing the old operation of opening the tumour and tying both extremities of the artery in that situation, or of amputating the limb. A slight pulsation in some instances returns in the tumour after the operation, but in general it subsides in the course of a few days: it rarely increases or continues long enough to constitute a secondary aneurism. Should this unfortunate circumstance take place, the debilitating treatment which is employed to promote a spontaneous cure should be rigidly tried before a second operation is undertaken *.

When the cavity of an aneurism is exposed by sloughing or ulceration, and hæmorrhage takes place after the ligature of the artery at a distance from the disease, the old operation of tying both extremities of the vessel where they open into the sac should be performed. If it fail, amputation is an ultimate resource. When the disease exists in the arm-pit or the groin, the old operation only is practicable under such circumstances; but when the aneurism is situated in a lower part of the limb, the condition of the surrounding parts will often render amputation advisable.

The quantities of coagulum which have been

* Page 145.

absorbed from aneurismal sacs are so great, that in no instance should the operation be omitted on account of the immense size of the tumour. I have known many pounds of coagulum absorbed from femoral and inguinal aneurisms without the slightest constitutional derangement. In some instances, the contents of the tumour become more solid after the operation: sometimes they become softer: in the latter cases I have observed that the absorption proceeded more rapidly. The facility with which immense quantities of coagulum are absorbed, and the danger which attends sloughing or ulceration of the sac, independent of the chance of hæmorrhage from the current which enters the tumour through collateral channels, constitute valid objections to the practice of opening an aneurism, and removing its contents after the operation. One of the greatest advantages of the modern operation consists in allowing the contents of the tumour to be removed by absorption, and thereby avoiding the dangers which attend the incision of the sac. I have known a few instances in which aneurisms burst, or were opened after the operation: tedious ulceration and a contracted state of the joint were generally the consequences.

I shall now consider a variety in the surgical treatment of this disease, which has been proposed and even tried both in this country and upon the

continent; and, lastly, I shall offer a few remarks upon those circumstances which may appear to preclude the operation for aneurism.

The existence of an aneurism in a situation where it is impossible to tie the artery above the tumour, and the rapidity with which the disease may be hastening to a fatal termination, added to the reasoning which may be adduced upon the subject, appear to justify the experiment of tying the artery immediately below the sac. The principle upon which a cure of the aneurism is expected to follow this operation, is founded upon the fact, that when blood is removed from the course of the circulation it generally coagulates. If an artery be tied immediately below an aneurismal sac, the blood which enters the latter being unable to pass forwards, will be placed, as it were, out of the course of the circulation, and in a similar situation to the blood which enters the extremity of a tied artery, and remains between the ligature and the origin of a collateral branch. In the latter instance it coagulates and forms a plug: in the former it is concluded, that, being placed in a similar situation, it would also coagulate, and that the disease would be subsequently cured by those processes which follow the obliteration of the cavity of the sac by a deposition of coagulum under other circumstances. It is essential, how-

ever, for the success of this mode of operating, that no large vessel arise from the sac, or from that portion of the artery which is situated between the sac and the ligature, for the stream of blood passing through the tumour may, under such circumstances, prevent the coagulation of its contents, and continue the disease. This practice was originally proposed by Desault *, and tried by Deschamps in a case of inguinal aneurism. I have inserted the following abstract of the important but horrible operation which Deschamps performed, to enable the reader to appreciate the inferences which it appears to me to afford.

" Albert Brondex, sixty years of age, a man of literary habits and a spare constitution, was admitted into the Hospital de la Charité. A circumscribed tumour, about seventeen inches in circumference, was situated in the upper part of his thigh, leaving only the breadth of a finger between it and Poupart's ligament. This swelling possessed all the characters of a true aneurism. It had existed six months, and commenced about five fingers' breadth below the groin in the course of the femoral artery. On the fourth day after his admission into the hospital, the tumour continuing to increase, I called a consultation. I

* *Œuvrès Chirurgicales* de DESAULT, par Bichat, tom. ii. p. 568.

proposed the ligature of the femoral artery below the aneurismal sac, hoping that the blood arrested in its progress through the vessel would coagulate in the tumour. The majority of my advisers were in favour of the proposal, which I executed in the following manner.

I made an incision two inches and a half in length in the course of the femoral artery below the tumour. The integuments and fascia lata being divided, I proceeded to raise the sartorius muscle which lies over the artery in the middle of the thigh. After searching for this muscle some time in vain, I continued the incision a little deeper, and separating the parts on the inside of the thigh, I traced the great adductor muscle, and found the sartorius thrust inwards. We then sought for the artery, which we expected to find in the situation which it usually occupies, but we could not discover the least pulsation or substance that could lead us to distinguish it. Several of the assistants endeavoured to find it, but without success. At length one of them carried his finger to the bottom of the wound towards the tumour underneath the sartorius muscle, where he thought he could trace the artery. I then detached the whole circumference of the muscle, but could not discover the least pulsation. It was proposed to cut the sartorius across in order to obtain a more distinct view

of the bottom of the wound. Although adverse to this measure, I consented; but our endeavours to find the artery were as unsuccessful as before. At last we returned to our original opinion, that the natural course of the artery was not altered. The discovery of a nervous filament, which is known to accompany the vessels in this situation, and which I had divided with the design of relieving the acute pain which the patient felt in the knee every time that this nerve was touched, induced me to adopt the following practice. I passed a needle mounted in a handle underneath the part where we were convinced the vessels were situated, and to obtain our object more certainly I included a small portion of the adductor muscle. The ligature, being passed, I raised its extremities, and placed my fingers upon the parts which it surrounded, in order that the obstructed blood might distend the artery and render it distinguishable, but no alteration could be discovered in consequence of the pressure. The parts were secured by a *presse-artère*, and I placed a ligature of reserve above that instrument.

The patient did not lose three ounces of blood during this operation. I inserted a small quantity of lint in the bottom of the wound, the sides of which were defended from the *presse-artère* by two light tents. Two or three compresses were placed above a pledgit spread with the balsam

of Arcæus, which covered the wound: a circular bandage was not applied. Bags filled with warm sand were placed along the leg and foot: the sensibility and heat of these parts did not undergo the slightest change, but the patient was extremely fatigued by this tedious operation, which occupied more than an hour, and by the acute pain which attended the laceration and stretching of the parts in our attempts to find the artery.

The increase of the tumour, which had been very remarkable from the tenth day of the month to the fourteenth, on the latter of which the operation was performed, did not cease after that time, and the pulsation in it continued as formerly. On the fifteenth and sixteenth the aneurism had extended even to the crural arch, and, if accurately examined, a slight purple tint was observed upon its summit. The limb preserved its natural heat: very little pain was felt in the thigh, which was slightly swoln. On the sixteenth the superficial dressings were removed, and the ligature, which had become rather slack, was tightened. On the seventeenth the condition of the patient was the same as before: his pulse was small, hard, and frequent. On the night of the seventeenth or eighteenth he complained of more pain, and particularly of an obtuse pain in the aneurism, which was increased in size. In the morning I found an evident swelling on the external surface of the

thigh: it was soft, and but slightly painful: the tumour continued circumscribed. On the eighteenth, the fourth day after the operation, the tumour still continued to increase: the pulsation was as violent as ever: the leg and thigh were swoln. All these circumstances evidently proved that the ligature of the artery below the tumour had not produced the effect which we had expected: we were convinced that the artery was tied, although several of the assistants doubted that fact. The condition of the patient was by no means favourable: his pulse was small, hard, and frequent: his age, and other unfavourable circumstances, tended to diminish the chance of success from a second operation, which the state of the patient demanded, unless he were abandoned to certain and speedy death. All these things being maturely considered, we resolved upon opening the aneurismal sac.

An assistant compressed the femoral artery, where it passes over the os pubis. The sac was then opened throughout its whole extent: the coagulum and recent blood which it contained were removed, and a probe being passed up the superior extremity of the artery, it was raised from its connexions, and a ligature was applied. The blood, however, continued to flow from the bottom of the sac. The inferior extremity of the artery was therefore tied: the hæmorrhage ceased, and the wound was dressed. The patient lost an

immense quantity of blood during this operation: his pulse became imperceptible, and he died in eight hours.

Deschamps examined the limb, and found, 1st. That the profunda, which generally arises from the femoral artery an inch and a half or two inches after that vessel emerges from the belly, was in this instance given off at the distance of ten lines. The two circumflex arteries were enlarged, but arose and were distributed in the usual manner. The trunk of the profunda was nearly as large as the femoral artery. The profunda was connected so firmly to the commencement of the aneurismal sac, that it was almost impossible to tie the femoral artery close to the tumour without the former vessel being wounded or included in the ligature. 2dly. That the ligature which was applied in the first operation included the artery, the femoral vein, and a small portion of the great adductor muscle: that in the second operation the upper ligature was situated three lines above the aneurismal sac, and included the femoral artery and a third of the profunda, which had been pierced by the needle: that the ligature of reserve, placed above this, passed between the femoral artery and the profunda, accurately surrounding the former: that the inferior ligature applied in the second operation was situated upon the artery six lines below the sac, and that the vein had been

wounded by the needle. Notwithstanding these wounds in the profunda and the vein, the blood had not escaped. 3dly. That the femoral artery was destroyed for the extent of two inches, about two inches and eight lines from its origin. The sac, at its commencement and termination, was of a funnel shape. About an inch below the sac there was a dilatation of the posterior part of the artery, the lining membrane of which was smooth, polished, and had undergone no organic change. The remainder of the tube was in a healthy state. 4thly. That an infiltration of purulent matter existed underneath the fascia lata in the diseased limb: suppuration had taken place between the muscles in the vicinity of the part in which the first operation was performed*."

In the account of this dissection it is not mentioned at what distance the artery was tied below the aneurism in the first operation: it is very evident, however, that some branches must have opened into that portion of the vessel situated between the ligature and the tumour; for when the superior extremity was tied in the second operation, the blood gushed from the inferior opening of the artery into the sac. Now this current must have been furnished by branches

* *Œuvrès Chirurgicales* de DESAULT, par Bichat, tom. ii. p. 572.

which opened into that portion of the vessel situated between the sac and the ligature which was applied in the first operation. If a stream continued to pass through the aneurism into branches which originated below it, the blood contained in the tumour was not at rest, and consequently did not coagulate: a cure could not therefore be expected to ensue upon the principles which led to the performance of the operation. I have seen two dissections which illustrate these arguments. The first was that of an inguinal aneurism in an old man. The tumour had existed a long time: at length it sloughed, and a profuse hæmorrhage ensued. The external iliac artery was tied, but the patient died on the fourth day, apparently from extreme debility. The condition of the artery where the ligature was applied I have already described*. A large aneurism arose from the femoral artery a little below its origin, and occupied the whole circumference of the vessel for a very considerable extent. The profunda originated from the bottom of the sac, which contained a great quantity of firm coagulum. The inferior extremity of the femoral artery in the sac was completely obliterated, not by a recently formed plug of coagulum, but by a consolidation and adhesion of its sides. The second case was

* Case XXXIII. p. 195.

a popliteal aneurism, of which I have also related some of the particulars*. The tumour in the ham sloughed after the ligature of the femoral artery: hæmorrhage ensued, and the limb was amputated. The inferior extremity of the popliteal artery, which had opened into the sac, was completely closed by a firm plug of coagulum: several branches originated from the sac and from the artery between the part at which the ligature had been applied and the tumour in the ham. Now the condition of both these aneurisms was the same as if the inferior extremity of the arteries had been tied close to the sacs. The disease in both instances increased after the obliteration of the inferior portion of the artery, because the blood continued to pass through the aneurisms into branches which arose from the sacs. The circulation through the tumours was not prevented by the obliteration of the inferior extremity of the artery; consequently the blood did not coagulate within them, although this event might have been expected, had not the branches which I have mentioned originated from the sacs.

A second instance in which the artery was tied below an aneurism occurred in this metropolis, and the event of the case I think admits of an explanation similar to that by which I have endea-

* Page 270.

voured to account for the failure of the operation which was performed by Deschamps. Mr. Astley Cooper was consulted in a case of aneurism of the external iliac artery which extended into the abdomen as high as the internal iliac, so as to render it impracticable to tie the artery above the tumour. The disease had thrust forwards the inferior portion of the abdominal muscles and Poupart's ligament. The rapidity of its progress threatened the life of the patient. The femoral artery was tied between the origins of the epigastric artery and of the profunda. The pulsation continued, but the tumour did not increase in size after the operation. The ligatures separated favourably. The aneurism diminished so considerably, that it was conceived in a little time, if its diminution continued, it would be possible to tie the external iliac artery above the tumour. The patient went into the country to recruit his general health, where the aneurism burst underneath the peritoneum, and he died in consequence of the extravasation of blood into the cellular membrane of the pelvis and scrotum. In this instance the femoral artery was tied below the origin of the epigastric and circumflexa ilii arteries: a current, therefore, continued to pass through the sac into these vessels; consequently the blood was not at rest in the aneurism, and did not coagulate. After the ligature of the artery, the blood was transmitted more readily

through the internal iliac than through the arteries which originated below the aneurism, namely, the epigastric and circumflexa ilii. The contraction of the sac, therefore, appears to have been the consequence of the diminution of the stream which passed through it, in the same manner as an aneurism contracts, although a current enters it after the ligature of the artery at a distance from the disease. It is to be regretted, that in the instance which I have now related, an opportunity could not be obtained of examining the actual condition of the parts after death.

From these observations I think we may conclude, that the effect of tying an artery immediately below an aneurism, in a case where no branches originate from the sac, or from the artery between the ligature and the tumour, has not hitherto been determined by experience. The termination of the two cases in which this practice has been tried, by no means destroys the probability of a happier result under other circumstances. There is strong reason to believe, that, if no branch originated from the aneurism, or from the artery below the aneurism, the blood would coagulate in the tumour, and that a cure would be accomplished by the absorption of this coagulum and the subsequent contraction of the sac. The principle upon which a cure is expected to follow this mode of operating, is the same as that upon

which varicose veins are cured by tying the superior part of the vessel. The obstructed blood coagulates in the dilated vein: the coagulum is absorbed: the cyst contracts, and the disease is cured. In Case XIX *, the subclavian artery was obliterated beyond an aneurism, which was situated at the commencement of that vessel. This little sac was filled with lamellated coagulum: its condition was very unfavourable to the retention of blood, in consequence of the extent of the opening by which it communicated with the aorta. The state of the parts, however, was the same as when an artery is tied immediately below an aneurismal sac. Sir Everard Home has remarked, that sometimes "the sac is protruded along the outside of the artery, and, by its pressure upon it, obliterates, in many instances, the lower orifice which communicates with the artery, and produces a total stagnation of the blood in the sac †." Such cases illustrate the probable event of this mode of operating, which merits attention, from the impossibility of tying the vessel between the disease and the heart, when an aneurism arises from the external iliac or subclavian arteries. It must be acknowledged, however, that it will be almost impossible, in any case, to ascertain that no branch arises from the sac, which, by conti-

* Page 111.

† *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 140.

nuing the circulation through the latter, may defeat the objects of the operation.

Finally, I consider it necessary to offer a few remarks upon those circumstances which may appear to forbid the operation for aneurism, or to diminish the chance of its success.

I have already observed*, that mortification of the limb is more frequently the consequence of the ligature of its principal artery in old than in young patients, on account of the resistance which the condition of the vessels at an advanced period of life affords to the establishment of a collateral circulation. The operation for aneurism, however, should not be omitted on account of the age of the patient, if the circumstances of the case in other respects appear to demand it, for it has often succeeded at very advanced periods of life. I have seen several aneurisms cured by the modern operation in patients above sixty years of age.

I have mentioned †, that when an aneurism has arrived at an immense size, by compressing the surrounding parts, it may obliterate the channels which are essential for a collateral circulation. This circumstance, although it points out the propriety of operating in an early stage of the disease, should not be allowed to preclude the operation, whatever

* Page 260. † Page 259.

may be the size of the tumour, for many pounds of coagulum have frequently been absorbed from aneurismal sacs after the modern operation. It is advisable, when the tumour is very large, to undertake the operation, because, if mortification ensue, the limb may then be amputated; and when the disease is situated in parts which cannot be removed, as the neck, the groin, or the arm-pit, the ligature of the artery is the only resource after all hopes have ceased of effecting a cure by abstinence and depletion.

The operation for aneurism should not be omitted although appearances of gangrene have taken place on the tumour; for, should it burst afterwards, it is probable that both extremities of the artery in the sac will be closed with coagulum, so as to prevent the occurrence of hæmorrhage. Mr. Astley Cooper has tied the external iliac artery in two cases of inguinal aneurism after gangrene had commenced. The tumours burst after the operation: hæmorrhage, however, did not ensue: the coagulum was discharged: the sacs granulated, and the sores gradually healed*. I have seen two instances in which the cavities of aneurismal sacs were exposed after the operation, without the occurrence of hæmorrhage. Scarpa tied the femoral artery in

* *Medico-Chirurgical Transactions*, vol. iv. p. 431.

a case of popliteal aneurism of prodigious size. The tumour burst on the thirty-sixth day after the operation. The coagulum issued out in great quantity, but not a drop of fluid arterial blood was discharged. Mortification immediately attacked this large sac, and the patient died in three days. The cavity of the artery was closed in the vicinity of the ham*. This event is not, however, to be universally expected, for in some cases which I have mentioned, hæmorrhage was the consequence of the rupture of the aneurism after the operation †.

When an aneurism exists in the course of the aorta or any of its primary branches, the violent action of the heart excited by an operation in the extremities may cause it to burst, and prove instantaneously fatal. Two cases have recently occurred in this metropolis in which the patients died during operations for popliteal aneurisms. In both instances it was found that a small aneurism at the root of the aorta had burst into the pericardium ‡. It is always prudent, therefore, before the operation, to inquire if the patient has symptoms which indicate the existence of aneurism

* *Treatise on Aneurism*, WISHART'S *Translation*, p. 408.

† See Case XXXIX, p. 268, and p. 270.

‡ *London Medical Review*, vol. ii. p. 420; and BURNS, *on Diseases of the Heart*, p. 226.

in the thorax or abdomen; and if that be the case, only a palliative treatment, by depletion, abstinence, and quietude, should be employed. The co-existence of aneurisms in the thorax or abdomen, and the extremities, is unfortunately by no means a rare occurrence. Unless, however, the operation be obviously prohibited by symptoms of internal aneurism, the cure of the disease in the extremities, if the patient be otherwise in a favourable state, should always be attempted by an operation. "If the operation prove sometimes unsuccessful from the rupture of an undiscovered internal aneurism, this circumstance cannot surely be brought forward as an objection to the operation, or laid to the charge of the operator. It argues no neglect or deficiency on the part of the operator; for it may happen in the practice of the most intelligent, as readily as in that of the most ignorant. It is an event which in general the most consummate knowledge can neither foresee nor prevent*."

* Burns, *on Diseases of the Heart*, p. 226. The occasional co-existence of aneurism in the thorax or abdomen, with that disease in the extremities, has been urged as an objection to the operation in general. This circumstance induces me to quote the following account of the different cases in which Mr. Astley Cooper had performed the operation for aneurism before the year 1809. It exhibits the success of Mr. Cooper's practice in this department of surgery, and affords incontrovertible evidence of the benefits of the operation, because both

The existence of more than one aneurism in the extremities at the same time should not

the successful and unsuccessful cases are mentioned. It is extracted from BURNS *on Diseases of the Heart*, p. 229.

" POPLITEAL ANEURISM.

Edward Powell, aged twenty-seven; operation, April 1802; at present resides near Reigate, Surrey; a patient of Mr. Martin's, of Reigate.

James Chapman, aged fifty-two; operation in the summer of 1802; now a servant of the treasurer of Guy's Hospital.

——— Cuthbertson, aged thirty; operation in 1803; now a coal-porter in London.

——— Campbell, aged twenty-six; operation in 1804; died in six weeks after. On examination, water was found in the pericardium, and an aneurism at the root of the mesenteric artery. The aorta was found much diseased.

A. B., sent into Guy's Hospital by Mr. Holt, surgeon, of Westminster; operation in August 1805; died at Christmas of the same year, in consequence of suppuration of the aneurismal sac.

Robert Darling, a patient of Messrs. Horsford and Hopke's, Radcliffe Highway; operation in 1806; recovered; he went into the north of England, since which I have had no account of him.

A. B., a patient of Mr. Jones, of Deptford; operation in 1806; died at sea, fifteen months afterwards; cause of his death unknown.

——— Jones, a patient of Mr. Holt, of Tottenham; died three weeks after the operation, with symptoms of tetanus.

Mr. —— Fox, aged sixty-nine, a patient of Mr. Butler, Hoxton; operation in March 1808; now lives in Bath Street, Hackney Road.

be allowed to prevent the performance of an operation, for several instances have occurred in

William Goldring; operation in May 1808, in Guy's Hospital; discharged cured.

FEMORAL ANEURISM.

A. B., a patient in Guy's Hospital, sent to me out of Buckinghamshire; femoral artery tied within two inches of Paupart's ligament; soon recovered; and I heard several months afterwards that he was perfectly well.

INGUINAL ANEURISM.

A. B., a patient in Guy's Hospital, whose leg had been amputated above the knee some years before; operation for aneurism performed by tying the femoral artery under Paupart's ligament, and above the arteria profunda; a single ligature only was used; this man died of hæmorrhage, fourteen days after the operation.

John Cowles, aged thirty-two; operation in June 1808; he recovered, but very slowly; he is now living in Beccles, in Suffolk.

CAROTID ANEURISM.

Mary Edwards, aged forty-four; operation in November 1805; died on the twenty-third day after the operation, from inflammation in the aneurismal sac; both ligatures came away on the twelfth day.

Humphrey Humphries, aged fifty; operation in June 1808; he is perfectly recovered, and now resides in Labour-in-Vain Court, near Bread Street Hill, London.

POSTERIOR AURAL ANEURISM.

A. B., a patient of Mr. Fry's, of Dursley, Gloucestershire; operation performed; I heard from Mr. F. some years afterwards, that this woman was perfectly well."

which the main arteries of two limbs have been tied with perfect success in the same patient. A man was admitted into St. George's Hospital who had an aneurism in the right ham: there was also a small aneurism in the popliteal artery of the other limb. The femoral artery of the right thigh was tied on the ninth of June by Sir Everard Home: the ligature was detached, and the wound nearly healed on the twenty-seventh day of the same month: the aneurism in the other ham was increasing very fast. The left femoral artery was tied five weeks after the first operation, and in nine weeks from that time he was completely cured of both diseases*. In a similar case, Mr. Freer has recently tied both the femoral arteries of the same patient, at the interval of a few months, in the Birmingham hospital. The aneurisms were situated in the hams, and were completely cured without the occurrence of an unfavourable symptom after the operations. The patient also whom Mr. Freer cured of an inguinal aneurism, by tying the right external iliac artery†, was afterwards admitted into the Glasgow infirmary with an aneurism in the left ham. The femoral artery was tied by Mr. Anderson, and the patient completely reco-

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 235.

† FREER, *Observations on Aneurism*, p. 79.

vered from that disease. He died, however, in a short time, in consequence of the rupture of an aneurism of the abdominal aorta*. In addition to those which I have mentioned, two instances have recently occurred in this metropolis in which the principal artery was successfully tied for the cure of aneurisms in both of the lower extremities of the same patients.

It appears probable that the ligature of one trunk accelerates the growth of the aneurism in the opposite limb; for in all the instances which I have mentioned, the second aneurism either commenced very soon after the first operation, or increased more rapidly when the circulation through the opposite trunk was obstructed. In the first case in which Mr. Abernethy tied the external iliac artery, the femoral artery of the opposite side had been successfully tied for a popliteal aneurism. The aneurism in the left groin increased so rapidly after the first operation, that at the end of five weeks it appeared "almost ready to burst; the tumour having acquired a pyramidal form, and the skin covering the apex having yielded so much as to form a kind of process from the tumour†." This circumstance strongly indicates the impropriety of

* Burns, *Surgical Anatomy of the Head and Neck*, p. 163.

† *Surgical Observations, on Aneurisms*, p. 234. Second edit.

delaying the first operation whilst the disease in the opposite limb is advancing. The second operation may be undertaken with safety a few days after the detachment of the ligature which was applied for the cure of the disease in the opposite limb.

I cannot conclude this subject without calling the reader's attention to the identity of the processes by which a spontaneous cure of aneurism is occasionally accomplished, and the effects produced upon the disease by the modern operation. If the patient be feeble, and the circulation languid, the cavity of the sac is gradually filled with strata of coagulum deposited from the blood which passes through it: by the absorption of this coagulum, and the contraction of the sac, a cure is ultimately accomplished. If a languid state of the circulation be induced by abstinence and depletion, these processes of spontaneous cure are promoted. If the artery be tied above an aneurism, the ingress of blood into the tumour is not entirely prevented, but the stream which passes into it from collateral branches is not sufficient either in quantity or in force to continue the disease. Under these circumstances the deposition of coagulum is promoted by the languid state of the circulation through the tumour: the cavity of the sac is gradually filled, and the same processes of absorption and contrac-

tion ensue as when the disease undergoes a spontaneous cure.

The cure of aneurism in general, whether effected spontaneously, or by the assistance of art, is, therefore, referrible to one principle,—the diminution of the force of the circulation through the sac. All which art can with safety accomplish, is to place the parts in a condition in which the powers of the economy are capable of remedying the effects of disease.

SECTION V.

ON CAROTID ANEURISM.

It is ascertained that the obliteration of the common carotid artery is not attended with disorder in the functions of the brain, and that aneurisms may be cured by the ligature of that vessel.

In the year 1749, Haller examined the body of a woman, about fifty years of age, in whom the ascending portion and the arch of the aorta were excessively dilated. This cyst contained grumous blood, and was lined with a membranous layer of coagulum, which extended into the left carotid artery, and completely obliterated the cavity of that vessel throughout its whole extent. This substance was of a white colour, and adhered so intimately to the internal coat of the artery, that it was with difficulty detached by dissection. It extended up the external carotid to the origin of the labial artery, and completely filled the contracted and slender trunk of the internal carotid, until it enters the foramen in the petrous portion of the temporal bone*.

Petit, in the year 1765, published an account of the dissection of a man who lived seven years after the obliteration of the common carotid artery. An

* *Opuscula Pathologica*, Obs. xix. tab. 1.

aneurism of the size of a pigeon's egg had existed underneath the angle of the lower jaw. By blood-letting, meagre diet, and quietude, in three months the tumour was reduced to half its size, and in two or three years only a small hard knot was perceptible. It continued in this state seven years, when the patient was seized with apoplexy, and died in a few days. "The right hemisphere of the brain was covered with bloody serum. Underneath this effusion the brain was healthy: no effusion had taken place on the surface of the opposite hemisphere; but when the ventricle was opened, five or six ounces of fluid blood escaped, and a mass of coagulum of the size of a pullet's egg remained. This coagulum was contained in a large cell, which it had formed in the substance of the brain. On the left side, in which this extravasation had taken place, the calibre of the carotid artery, and of the branches which arose from it, appeared one-third larger than in their natural state. The right carotid artery was completely obliterated from the part at which it separates from the subclavian artery to its division into the two principal branches opposite the angle of the lower jaw. This artery, which is generally as large as the tip of the little finger, was converted into a slender cord about two lines in diameter, in which no vestige of a cavity could be traced. At the commencement of this artery, where it sepa-

rates from the subclavian, a small aneurism as large as a nutmeg was situated. The membranes of which this sac was composed were very thin: its cavity was filled with a substance partly resembling lard, and partly dried blood. A very small opening was distinguishable, by which it had communicated with the cavity of the artery before the obliteration of the latter. At the part where the aneurism had existed near the angle of the jaw, a hard oblong knot as large as an olive, without any cavity in its interior, was found*."

Dr. Baillie met with a similar condition of the carotid artery in a subject that was brought to the dissecting room. In the right carotid artery, just before it divides into the external and internal carotids, an oval uniform swelling, about an inch and a half in length, was discovered. The diameter of the artery at this part was scarcely enlarged to more than twice its ordinary size. "The swelling was firm, giving the same resistance to the feeling as a healthy absorbent gland; and, if it had been felt through a thin layer of muscle, would certainly have been mistaken for one of a large size. When the coats of the artery were cut through, its cavity was found to be completely filled with a firm coagulum of blood, which had not the appearance of blood being recently coagulated after death,

* *Mém. de l'Acad. Roy. des Sciences*, de l'Ann. 1765, p. 758.

but had the appearance of an old aneurismal coagulum. The coagulum adhered every where so firmly to the inside of the vessel, that, in separating it, the inner coat was, in many places, peeled off along with the coagulum. In cutting into its substance, it was found to consist of distinct layers, as in a common aneurism. There was no part of it which had the appearance of being recently formed, and therefore there cannot be any doubt of its having existed for a considerable time before the man's death. It is obvious then, that in this case a coagulum had been formed in the carotid artery, undergoing the same process as in aneurism, and that the tendency to aneurism had remedied itself. The whole cavity being filled up with coagulum, there was no circulation whatever at this part. In the left carotid artery of the same person, exactly before its division into the external and internal carotids, a dilatation and coagulum were formed; but the dilatation had more the shape of a common aneurismal sac, and the coagulum did not entirely fill up the cavity of the vessel. There was only, however, a small canal for the current of blood*."

Pelletan found the carotid artery obliterated by the pressure of a large aneurism of the arch of the aorta.

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 121.

The artery contained a plug which extended from the part compressed by the aneurism to its division into the external and internal carotids*. Mr. Astley Cooper has mentioned a similar case in which the carotid artery was obliterated by the pressure of an aneurism of the arch of the aorta. The sac passed into the neck behind the sternum, and reached as high as the side of the larynx, producing great difficulty in deglutition and breathing. The patient's mind continued perfect till his dissolution, and he had no paralytic symptoms. The left carotid artery was obliterated, as far as its division, into external and internal, by a clot adhering to the inner coat of the artery†.

These dissections proved, long before the carotid artery was tied in the human subject, that the brain would be supplied with a sufficient quantity of blood for the due performance of its functions, when one of its principal arteries was obliterated. This observation derived additional confirmation from the experiments of physiologists, who found that brutes would survive the ligature of even both carotid arteries‡. But the important conclusions

* *Clinique Chirurgicale*, tom. i. p. 68.

† *Medico-Chirurgical Transactions*, vol. i. plate 11. fig. 2.

‡ Valsalva repeatedly tied both carotid arteries in dogs. In one experiment the animal lived twenty-two days, when he was killed for the purposes of dissection. In two other experiments the animals were destroyed in a much shorter time.—See

which may be deduced from these facts, were not, until lately, applied to the treatment of aneurisms. Mr. Astley Cooper first tied the carotid artery for the cure of aneurism, and several cases have occurred which establish the success of this operation, which may justly be regarded as one of the greatest improvements in modern surgery.

The first patient upon whom Mr. Cooper tied the carotid artery was a woman, forty-four years of age. She was admitted into Guy's Hospital on the 23d of October, 1805. "The account she gave of the disease was, that the tumour appeared five months before, situated rather above the middle of the neck, its size at first being only that of the end of the finger; that it beat with very great force, and occasioned a strong pulsation in the brain; that it gradually increased upwards, until it reached the lower jaw, and extended downwards below the middle of the neck; that for a fortnight previous to her admission, the pulsation in it and in the brain had been so strong as to prevent her sleeping; that the scalp on that side was tender, so as scarcely to bear the touch; that she had great difficulty in taking any solid food,

VALSALVA, *Opera*, *Cura* MORGAGNI. Epist. xiii. p. 507. It is probable that the carotid artery was tied in brutes even in the time of Galen. The experiment is mentioned by Van Swieten, Lower, Drelincurtius, Pechlinus, and several writers.

and was constantly teazed with a violent cough. Upon examination of the swelling I found," Mr. Cooper observes, " that it occupied two-thirds of the neck; it had a very strong pulsatory motion, and the skin was thin at its most prominent part." At the time of the operation the tumour " reached from near the chin beyond the angle of the jaw, and extended downwards to within two inches and a half of the clavicle. I made an incision two inches long, on the inner edge of the sterno-mastoid muscle, from the lower part of the tumour to the clavicle, which laid bare the omo- and sterno-hyoideus muscles, which being drawn aside toward the trachea, exposed the jugular vein. The motion of this vein produced the only difficulty in the operation, as under the different states of breathing it sometimes presented itself to the knife tense and distended, and then as suddenly collapsed. Passing my finger into the wound to confine that vein, I made an incision upon the carotid artery, and, having laid it bare, I separated it from the par vagum, and introduced a curved aneurism needle under it, taking care to exclude the recurrent nerve on the one hand, and the par vagum on the other. The two threads were then tied about half an inch asunder, being the greatest distance to which they could be separated; I thought it proper not to run the risk of a hæmorrhage, by dividing

the artery, as I was fearful the ligatures would be thrown off by the force of the heart, and the distance was too small to allow of any means being used to prevent it. As soon as the threads were tied, all pulsation in the tumour ceased, and the operation being concluded, and the wound superficially dressed, she rose from the chair in which she sat during the operation, and was immediately seized with a fit of coughing, which I thought would have terminated her existence. This seemed to arise from an accumulation of mucus in the trachea which she could not expel; it continued about half an hour, when she became more tranquil."

On the first day after that on which the operation was performed, the pulsation in the tumour had not returned; that in the brain had ceased, and there was no appearance of diminution of nervous energy in any part of the body. The symptoms were favourable until the seventh day, when considerable constitutional irritation came on; her right arm and leg were benumbed, and she moved them with great difficulty. These symptoms were relieved, but she was unable to swallow solid food, and troubled with a frequent cough. On the eleventh day the ligatures were drawn from the wound. On the twelfth and thirteenth days, her state appeared in every respect improved: the tumour was reduced in size, and

she swallowed with less difficulty. On the fourteenth day a high degree of constitutional irritation came on: the tumour was enlarged, and very sore upon pressure; the wound was as large as immediately after the operation, and discharged a sanious serum: she complained of a great difficulty in swallowing, and of a most distressing cough, after the fits of which she hooped violently: her pulse was quicker, and her left arm again weaker than the other. From this time the tumour increased, and the skin over it became of a brownish red colour. On the seventeenth day her pulse was one hundred and eight, and small: she was unable to swallow even her saliva, and every attempt at deglutition produced a violent cough. She died on the nineteenth day.

"Upon dissection the aneurismal sac was found inflamed, and around the clot of blood which it contained there was a considerable quantity of pus. The inflammation extended on the outside of the sac along the par vagum nearly to the basis of the skull. The glottis was almost closed, and the internal surface of the trachea was inflamed, coagulating lymph adhering to its mucous membrane. The sudden increase which the parts had undergone from inflammation, added to the size of the tumour previous to the operation, had occasioned so much pressure upon the pharynx, that it would not easily admit a bougie of the

size of a goose quill. The nerves sustained no injury, the ligature having passed between the recurrent and the artery on the one hand, and the par vagum on the other. The cause of death was the inflammation of the aneurismal sac, and the parts adjacent, by which the size of the tumour became increased, so as to press on the pharynx and prevent deglutition, and upon the larynx, so as to excite violent fits of coughing, and ultimately to impede respiration *."

This case established the important fact, that the carotid artery might be tied, and the ligatures detached with safety, and no doubt existed, that under more favourable circumstances those effects would be produced upon the aneurism by which the cure is ultimately accomplished after the operation in other parts of the body.

In the year 1808, Mr. Cooper repeated this operation, and the event of the case fully established the principles upon which it was undertaken. The aneurism had existed six or seven months. It was attended with great pain on the left side of the head, and a sense of pulsatory motion in the brain. The tumour affected the patient's speech so as to make him extremely hoarse, and produced slight difficulty in breath-

* *Medico-Chirurgical Transactions*, vol. i. p. 1. plates I. & II.

ing. Upon attempting to stoop, he had an insupportable feeling, as if his head would burst; a giddiness; loss of sight; and almost total insensibility. The tumour was seated just below the angle of the jaw, and about the acute angle which is made by the great division of the common carotid. It was about the size of a pullet's egg, and prominent in its middle. The neck was of considerable length, so as to give ample space for exposing the carotid artery.

" I began my incision," says Mr. Cooper, " opposite the middle of thyroid cartilage from the base of the tumour, and extended it to within an inch of the clavicle, on the inner side of the mastoid muscle. On raising the margin of this muscle, the omo-hyoideus could be distinctly seen crossing the sheath of the vessels, and the nervus descendens noni was also exposed. I next separated the mastoid from the omo-hyoideus muscle, and the jugular vein became apparent, which being distended, spread itself over the artery. Drawing aside the vein, the par vagum was evident, lying between it and the carotid artery, but a little to its outer side. This nerve was easily avoided. A blunt iron probe, constructed for the purpose, was then passed under the artery, carrying a double ligature with it. Two ligatures being thus conveyed under the artery, the lower was immediately tied. I next detached

the artery from the surrounding parts, to the extent of an inch above the lower ligature, and then tied the upper. Lastly, a needle and thread were passed through the artery above one ligature and below the other. The division of the artery was then performed. Nothing now remained but to dress the patient, and this was done by drawing the parts together by adhesive straps, the ligatures hanging from each end of the wound, and by laying on a piece of lint retained by straps of adhesive plaister."

Immediately after the operation, the patient, for the first time since two months after the formation of the tumour, was relieved from a distressing pain which extended up the left temple, accompanied by a violent throbbing of all the arteries of that side. This pain never returned. The pulsation in the tumour had not entirely ceased, although it was so much diminished as to become obscure. The patient had scarcely an unpleasant symptom after the operation. He was sometimes troubled by a slight cough and pain in the head, but these symptoms subsided as the tumour decreased. On the third day the swelling became firm, and its contents were gradually absorbed. Its pulsation, though slight, was perceptible more than two months after the operation. The upper ligature came away on the twenty-second day, and the lower on the

twenty-third. The tumour was scarcely apparent on the twenty-fourth day. The fascial and temporal arteries on the left side could not be felt. In less than three months he was discharged cured, and returned to his occupation as a porter*.

In less than a year after Mr. Cooper tied the carotid artery in the last case that I have mentioned, the operation was successfully repeated by Mr. Travers in a case of aneurism by anastomosis in the orbit. This case is particularly interesting, not only because it was the second instance in which the carotid artery was successfully tied, but also because it proved that the disease of the minute arteries, termed aneurism by anastomosis, may be controlled by the ligature of the trunk from which it is supplied.

Mr. Travers's patient was a woman, thirty-four years of age, who some years before the operation perceived the commencement of a pulsating tumour, which increased until it filled the greater part of the orbit, thrusting forwards the eyeball, and projecting at the inner canthus in the form of two distinct sacs. Compression and cold applications were tried without advantage. Excision was clearly impracticable without extirpation of the eye; and from the great displacement of the globe, and the obvious origin

* *Medico-Chirurgical Transactions*, vol. i. p. 222.

of the disease within the orbit, the result of such an operation was most precarious. Careful compression of the temporal, angular, and maxillary arteries, produced no effect upon the tumour. When the thumb was applied to the trunk of the common carotid, the pulsation ceased altogether, and the whiz in the smaller swelling was rendered so exceedingly faint, that it was difficult to determine whether it continued or not. Being satisfied of the growth of the disease; knowing, from the result of Mr. Cooper's case, that the carotid artery might be tied with safety; and particularly reflecting that the obstruction of such a channel must, at all events, be followed by a sensible and permanent diminution of the impulse of blood destined to the disease, Mr. Travers proceeded to the operation.

"The patient was laid supine; the neck raised by a pillow; the chin slightly turned to the left shoulder. An incision, about two inches and a half in length, was commenced at the distance of one inch above the sternal extremity of the clavicle, and carried in an oblique direction along the anterior edge of the mastoid muscle. The fibres of the muscle being exposed, its edge was raised, and the sheath of the vessels cautiously cut open on the tracheal side. Through this opening, which was of very small extent, a curved-eyed probe, carrying a stout round ligature, was passed

beneath the artery, care being taken to exclude the nerve. The probe being cut away, the ligatures were drawn apart from each other, the lower being tied at the lowermost point of the denudation of the artery, the upper at the highest. They were about one-fourth of an inch distant; and whilst they were tightened, the division of the internal coat of the vessel could be distinctly felt. The lips of the wound were lightly brought together by adhesive straps, and the ligatures drawn out opposite to the point of their application on the artery."

This patient speedily recovered. The upper ligature was detached on the twenty-first, and the lower on the twenty-second day. The wound healed quickly; and at the end of the fifth week she could perform all the duties of her situation as well as before the operation*.

I have great pleasure in laying before the reader a third case, in which the carotid artery has been successfully tied for the cure of aneurism. I have inserted it in the interesting language in which it was communicated to me by my friend who performed the operation.

* *Medico-Chirurgical Transactions*, vol. ii. p. 5. The effect produced by this operation upon the disease in the orbit will be related when treating of aneurism by anastomosis.

CASE XL.

THE subject of this case had gradually declined into an increasing melancholy. She courted solitude; her manner was mournful and silent; she seldom spoke; took no interest in her family or friends, and withdrew altogether from society About six weeks ago she retired to her chamber and stabbed herself in the neck, just under the angle of the jaw, with a very small and delicate pen-knife. She threw herself upon her bed, and was found in the morning pale, faint, and motionless, with her room deluged with blood. The right side of her body was paralytic; her features distorted; her visage pale and bloodless; her voice and strength entirely gone, with one hand lying powerless by her side.

About a fortnight after this melancholy day, a small tumour was observed under the angle of the jaw. This swelling was extremely small—not bigger than the point of the finger, and resembled, in all respects, an indurated lymphatic gland. No doubt was entertained of its being merely such, and it was rubbed with a solution of camphor. But it soon excited more particular attention, for the patient herself remarked, that it had a strong pulsation, which was at first believed to arise from the stroke communicated from the arteries below to a swelled gland—so slowly did this tumour in-

crease, or assume its true character. But in the fifth week after the wound, the tumour had increased in size. That fluctuation, which had for ten days been ascribed to the suppuration of a lymphatic gland, was now plainly attended with pulsation. The puncture of the artery had been extremely small: the excessive loss of blood, such as to occasion hemiphlegia, had moderated the force of the circulation, and the cellular substance and arterial sheath had made sufficient resistance to restrain the effusion. The first effusion was coagulated into a firm small knot; but as the system filled again with blood, and the artery began to beat with its wonted strength, the effusion began anew. The first clot was floated in recent blood, attended with obscure fluctuation and distinct pulsation—such as was remarkable to the patient herself even in her torpid state of feeling. In proportion as the palsy began to disappear, and the benumbed hand to recover its power, this new and formidable disease was established. The characters of the aneurism were most unequivocal. It was evident that the disease was increasing, and that the operation ought not to be delayed. The tumour was about the size of a pigeon's egg. It was situated directly underneath the angle of the jaw, and excited a dreadful sense of suffocation. It possessed a strong distinct pulsation, and a very sensible fluctuation at the most prominent and

tumid part. The state of the patient, every way so forlorn and melancholy, excited sincere interest. She was silent, mournful, dispirited, resolved against life or any prospect of happiness, yet resigned to whatever treatment might be proposed to her. To tie the carotid artery was the only resource: the operation was accordingly performed in the following manner.

The patient was seated on a chair. An incision three inches in length, commencing near the root of the tumour, was made through the integuments down to the anterior margin of the mastoid muscle. The belly of that muscle being raised, it was held back by two slightly curved spatulas, and the integuments on the opposite side of the incision were drawn aside. The sheath of the vessels was thus exposed, and a slight trace of the omo-hyoideus muscle was observed crossing the lower part of the incision. The sheath was opened, and a double ligature, well waxed, and afterwards oiled, was passed underneath the carotid artery by means of a small silver probe. The upper ligature was tied first, in case of the artery proving brittle. The lower was then tied. They were drawn firmly and steadily, but so as surely not to cut, and yet effectually to mortify the part by stopping all circulation in the coats of the artery. The two ligatures were not separated far from each other: they operated, therefore, almost as one. The

jugular vein afforded no trouble in the operation: it was not even seen. The artery was tied a little above the middle of the neck, near the tumour, about the breadth of three fingers from the angle of the jaw. The wound was so little formidable, that three slips of plaster actually covered it.

The dressings were changed daily. A thin serum, tinged with blood, and blackened by the plaster, exuded from the wound, which, except in the centre, was united by the sixth day. No attempt was made to withdraw the ligatures. The lower one came away whilst gently washing the sore on the morning of the fourteenth day, and the upper was dragged out by an attempt to cut it shorter with a pair of coarse scissars.

The pulsation in the tumour ceased the very instant that the ligatures were tied. The swelling decreased rapidly, but had not entirely disappeared when the patient left her surgeon. There remained a small hard kernel. The gradual improvement of the power of deglutition marked the gradual subsidence of the tumour, which pressed inwards against the pharynx. No change was perceived in the state of the patient's mind after this operation: she still remained melancholy and dejected*.

* The following note, which relates to another case in which the carotid artery has been successfully tied, is inserted by Mr. Wishart, in his translation of SCARPA's *Treatise on Aneurism*, p. 381. "Hebenstreit, in the fifth volume of his translation

Aneurisms in the neck generally arise from the carotid artery at the point of its bifurcation. Depositions of calcareous matter, and præternatural dilatations of the artery, are by no means unfrequent in this situation. The tumour is generally situated underneath the angle of the jaw; and as it increases in size by pressing upon the larynx and pharynx, it produces an irritable state of those parts, and extreme impediments to respiration and deglutition. It is in this manner that carotid aneurisms frequently prove fatal. In the first case in which Mr. Astley Cooper tied the carotid artery, the tumour inflamed after the operation, and increased so as to press on the pharynx and prevent deglutition, and upon the larynx so as to excite violent fits of coughing, and ultimately to impede respiration*. Mr. Cline tied the carotid artery in St. Thomas's Hospital, in the year 1808. The patient was a strong middle-aged man. The tumour, which was large, had been particularly rapid

of Mr. B. Bell's *System of Surgery*, mentions a case which he had met with where the external carotid artery was wounded in the extirpation of a scirrhous tumour. The profuse hæmorrhage which instantly ensued would soon have destroyed the patient, if the surgeon had not immediately recollected himself, and tied the trunk of the artery. The operation was successful, and the patient lived many years after it."

* *Medico-Chirurgical Transactions*, vol. i. p. 9.

in its growth. The other circumstances of the case were by no means favourable. Respiration and deglutition were effected by the pressure of the tumour, which had pushed the larynx from its straight course. The patient had a very frequent and troublesome cough. The pain was confined to the tumour and corresponding side of the face. All these symptoms were relieved for twelve hours after the operation. They then returned in an increased degree, particularly the cough and difficulty of swallowing, accompanied with much irritative fever, to remove which medicine proved inefficient. The man died on the fourth day after the operation*. Mr. John Bell has related a case of carotid aneurism which proved fatal in a similar manner, by the irritation and pressure which it produced upon the larynx and pharynx †. These observations strongly point out the propriety of performing the operation for carotid aneurism whilst the tumour is small, and does not produce irritation in the important organs situated in its vicinity. It is always desirable that the operation for aneurism should be performed whilst the disease is in its early stage; but in this situation it is an object of the greatest importance; for, independent of the direct effects produced by the pressure of

* *London Medical Review*, vol. ii. p. 96.

† *Principles of Surgery*, vol. iii. p. 250.

the tumour upon the larynx and pharynx, the constant cough with which carotid aneurisms are generally attended, will be liable to cause the recent adhesion at the extremity of the tied artery to be torn asunder, and in that manner to produce secondary hæmorrhage.

It is not only for the cure of aneurisms of that vessel that the ligature of the carotid artery may be required. Mr. Travers's case proves that the disease in its branches may be controlled by the ligature of the trunk: hence in aneurisms by anastomosis, which, from their extent of situation, cannot be extirpated, it may be necessary to perform this operation. In wounds of the neck, in which the carotid artery or its principal branches are divided, it may sometimes be necessary to tie that vessel. In the following case of extensive wound, the carotid artery was tied by Mr. Abernethy. It is right, however, to observe, that the effects described in this instance did not occur in those cases in which the carotid artery has subsequently been tied.

A man was gored in the neck by a cow. The horn entered by the left side of the cricoid cartilage, and penetrated as far as the vertebræ: it then passed upwards on the bodies of those bones, nearly as high as the bottom of the skull: afterwards it came out behind the angle of the jaw,

exposing, and in some degree injuring, the parotid gland in its passage, and lacerating the skin of the face as high as the middle of the ear. The internal carotid, and all the primary branches in front of the external carotid artery, were lacerated. Notwithstanding the size of the vessels which had been torn, they did not immediately bleed. The blood, however, was soon observed to flow in streams down the neck, nor could general pressure upon the wound prevent hæmorrhage. By compressing the carotid artery against the lower cervical vertebræ, the hæmorrhage was restrained. Attempts were first made to tie the more superficial arteries; but the edges of the wound being lacerated, the first ligatures tore away portions of the flesh, and did not secure the vessels. It was deemed necessary to enlarge the wound to get at the trunk of the carotid artery, and an incision being made between that vessel and the trachea, in a direction parallel to each of these parts, Mr. Abernethy passed his finger beneath the trunk of the carotid artery, and, by compressing it between that finger and his thumb, effectually restrained the hæmorrhage. When the pressure was remitted, a torrent of blood gushed from the bottom of the wound. A ligature was therefore passed around the trunk of the carotid artery about an inch below its division, by means of which the flow of blood

was commanded. The ligature was tied, and the edges of the wound brought together by slips of plaster. About five hours after the accident, the state of the patient seemed greatly amended. His pulse was moderately full, strong, and not very frequent. He appeared tranquil, and perfectly rational. During the night, however, he became unquiet, feverish, and delirious. He had been several times affected by slight convulsions, which had increased. His pulse was one hundred and thirty in a minute, and hard. His skin was hot, and he lay inattentive to external objects. The convulsions appeared to be mitigated by the use of opium, but the strength of the pulse gradually declined, and after a severe convulsion fit, the patient died, thirty hours after the ligature of the carotid artery.

" The body was examined on the following day. The brain appeared to have suffered a considerable degree of inflammation. The vessels of the pia mater appeared as if they were injected, and in many places upon the surface of the convolutions of the cerebrum there even seemed an effusion of blood, producing that appearance usually termed bloodshot. There was a very considerable deposition of gelatinous substance between the tunica arachnoidea and the pia mater. The vessels passing through the substance of the brain, though fuller than common, were not particularly turgid. A considerable quantity of water, of a light brown

colour, and slightly turbid appearance, was found in the ventricles, whilst the firmness of the sides of those cavities sufficiently indicated that the collection had not preceded the accident. On examining the neck, the carotid artery was found to be the only part included in the ligature. The superior thyroideal, lingual, and fascial branches of the external carotid, were torn off from the trunk, and the internal carotid was rent across, as has been already mentioned. Neither the trunk of the eighth pair of nerves, nor the great sympathetic, nor those of the tongue, appeared to have suffered injury. The superior laryngeal, and the descending branch of the ninth pair, were the chief nerves injured by the accident*."

In a former part of this treatise I have advanced some observations on the mode in which the brain is supplied with blood after the obliteration of one carotid artery†. The transmission of blood to the brain through four large arteries, appears to provide that important organ, in its natural state, with a double circulation; so that when one of its principal arteries is obliterated, the brain is at once supplied by the others with a sufficient quantity of blood for the due performance of its functions.

* *Surgical Observations, on Injuries of the Head*, p. 115. Second edition.

† See page 242.

A collateral circulation within the skull is carefully provided for by the large inosculations of the arterial trunks, without the intervention of minute anastomosing ramifications. The brain appears to possess a double circulation, that its supply of blood may not suffer even a momentary interruption when one or more of its main arteries is rendered impervious. This arrangement is the more necessary, from the slight degree of enlargement of which the vessels of this organ are susceptible in consequence of their passage through bony canals; and probably it may obviate the effects which the dilatation of minute branches would produce upon the brain. It is true that when one carotid artery is obliterated, the branches by which the two carotids anastomose with each other, and with the subclavian arteries, will transmit a stream into the superior portion of the obliterated vessel before it enters the skull; but in an experiment which I have mentioned*, the aggregate of these anastomosing tubes was not equal to the calibre of one carotid artery in its natural state, and the difference was so considerable as to induce me to conceive that the brain could not be suddenly deprived of so large a portion of its supply of blood, unless, in its natural state, a greater quantity

* Page 244.

of that fluid were sent to it than is requisite for the due performance of its functions. It appears therefore probable, that a collateral circulation is originally provided for the brain, so that when one of its main arteries is tied, a sufficient quantity of blood is at once supplied by the others, without the occurrence of those changes in the minute ramifications which take place after the ligature of an artery in most parts of the body.

This opinion derives considerable illustration from the interesting case which I have quoted from Haller*. Not only was the common carotid artery obliterated, but a plug, intimately connected with the lining membrane of the vessel, extended into the external carotid; and completely filled the slender and contracted trunk of the internal carotid artery, until that vessel enters the foramen in the petrous portion of the temporal bone. In this instance the brain must have been supplied with blood by three arteries; for, although a stream might be conveyed through anastomosing branches into the external carotid above the point of its obliteration, the blood could not have passed through the internal carotid into the skull. Haller has not mentioned whether the other carotid and the vertebral arteries were larger than usual.

* See page 314.

The following is the mode of tying the carotid artery:

The patient being placed upon a table in a horizontal position, with the head slightly elevated by a pillow, the operator commences an incision two inches and a half in length, in the direction of the inner margin of the mastoid muscle, terminating an inch above the sternal extremity of the clavicle. The fibres of the mastoid muscle being exposed, its edge is to be raised by dividing the loose cellular membrane which connects it to the sterno-hyoideus muscle. The mastoid and sterno-hyoideus muscles being drawn asunder, the omo-hyoideus will be seen at the upper part of the incision, crossing the sheath of the vessels which are situated at the bottom of the wound. The descending branch of the ninth pair of nerves will also sometimes be seen upon the sheath of the vessels. The alternate collapse and dilatation of the jugular vein, and the pulsation of the carotid artery, will be distinctly perceived. An assistant is now to compress the jugular vein, by placing his finger above the superior extremity of the incision, so as to prevent the passage of the blood through the vein, and render the sheath of the vessels flaccid*. With a pair

*In two instances in which I have seen this operation performed, the only difficulty arose from the dilatation and contraction of the jugular vein, which in the former state was expanded over and completely concealed the carotid artery. In one of these

of forceps the operator pinches up a small portion of the sheath of the vessels, and, carrying the edge of his knife in a horizontal direction, as in opening a hernial sac, he makes a small incision through it immediately over the carotid artery. This opening into the sheath of the vessels may be enlarged so as to admit the point of an aneurism-needle, which is to be insinuated between the artery and vein. By pressing it gently, but steadily forwards, in close contact with the artery, which is to be fixed by the fore finger of the operator's left hand, and by moving it slightly upwards and downwards, the point of the instrument will be made to appear on the tracheal side of the artery. By retaining the aneurism-needle in close contact with the artery, the operator will avoid including the par vagum, which is situated underneath and between the artery and vein. The ligature* being passed

instances, the mode which I have mentioned of compressing the jugular vein above the incision, enabled the operator to open the sheath of the vessels with facility; in the other, the operator compressed and drew aside the vein with the fingers of his left hand.

* If the artery be detached to a greater extent than is requisite merely for the passage of the aneurism-needle underneath it, two ligatures should be applied, for the reasons which I have stated at page 223, but it will be prudent not to divide the vessel in the interspace; for, should the ligature from any

under the artery, the aneurism-needle is to be withdrawn. The ligature is to be firmly secured with two common knots, and brought out of the wound immediately opposite to the part at which it is situated upon the artery. The edges of the incision are to be retained in contact solely by slips of adhesive plaster.

cause slip off when the artery has been tied low in the neck, it will be extremely difficult, if not impossible, to secure the vessel, or to command the hæmorrhage. If the detachment of the artery be merely sufficient for the passage of the aneurism-needle underneath it, a single ligature may, I conceive, with confidence be relied on. In three of the cases in which the carotid artery has been tied and the ligatures detached with safety, two ligatures were applied, but the vessel was not divided in the interspace. In one instance, Mr. Astley Cooper divided the vessel. The patient recovered. In this and most operations for aneurism, the surgeon will find it convenient to employ an aneurism-needle with a much narrower curve than that which is usually given to this instrument. To obviate the difficulty of passing a common aneurism-needle round an artery in a deep and narrow wound, Mr. Abernethy has recommended the employment of "needles made with handles of pure, and consequently flexible, silver, and with steel points that have edges just sharp enough to pass through the cellular substance, but neither so pointed nor so sharp, as to endanger the wounding any parts of consequence that may be contiguous to those round which they are passed. When the points of these instruments were once passed underneath the vessel, the surgeon could bend their handles so as to accommodate them to the space they have to turn in."—*Surgical Observations on Aneurisms*, p. 243. Second edition.

The patient is to be placed in bed, with the head slightly elevated, and bent towards the sternum, so as to place the artery as much as possible in a relaxed condition. The head may be secured in this position by a bandage passed over it and underneath the armpits. The wound should be dressed on the fourth or fifth day, and every circumstance avoided which can produce general or local irritation.

SECTION VI.

ON AXILLARY AND SUBCLAVIAN ANEURISMS.

NUMEROUS instances have occurred in which the arm has received a sufficient quantity of blood for its support, after the obliteration of the subclavian and axillary arteries.

In a former part of this treatise I have related a case in which the left subclavian artery and several of its most important branches were obliterated by the pressure of an aneurism of the aorta. In this case, a small aneurism existed at the commencement of the subclavian artery, the cavity of which, from the point where it emerged from the little sac, was completely filled with a firm ligamentous substance, extending into the vertebral, the internal mammary, and superior intercostal arteries. The inferior thyroid artery was the first branch, which remained pervious, and through it the blood passed from the superior thyroid into the subclavian artery, which, although much contracted, was pervious from this point. The limb was well nourished, and possessed its natural powers, notwithstanding the obliteration of the commencement of its main

artery and these important branches *. I have also extracted an interesting case from the *Journal de Médecine*, in which a similar state of the vessels was observed. In this instance, " the right subclavian artery was slightly dilated, and contained, from its origin to the part which passes behind the anterior scalenus muscle, a dark-coloured clot of the consistence of jelly. That portion of the vessel which passes behind the scalenus, for the extent of an inch and a half, was filled by a very firm gray plug, which was impermeable to the blood, and adhered so intimately to the coats of the artery, that it could not be separated without their laceration. All the branches of the subclavian artery originated from that part of the vessel the cavity of which was obliterated, and were filled with gray clots that adhered very firmly to their coats, and extended various distances into their cavities. From the termination of these clots the arteries were pervious, and received blood from branches communicating with those of the opposite side, or from the same side below the disease. To the origin of the common scapulary, the axillary artery was filled with a clot which did not adhere to the sides of the vessel, and was of a light colour. Below the origin of the common scapulary, which, as

* Case XIX. p. 111.

well as the circumflex arteries, was remarkably dilated, the other vessels in the limb were only distinguishable from those of the opposite side by the diminished size of their calibre*." In the same publication another case is recorded in which the right subclavian artery was obliterated, and converted into a ligamentous substance for the extent of more than two inches. The commencement of the artery contained a conical clot. An aneurismal sac arose from the thoracic aorta. This sac had communicated with the aorta by two openings, eight or ten lines in diameter, which were completely sealed with firm coagulum, so as to destroy the communication between the cavity of the sac and that of the artery †.

In these cases, the only unusual circumstance which was observed during the life of the patients, was the deficiency of the pulse at the wrist. The

* See page 113.

† *Journal de Médecine*, par Corvisart, Leroux, et Boyer, tom. ii. p. 29. Corvisart also relates a case in which he found the left subclavian artery so much contracted, from about an inch beyond its origin, that the head of a small pin could with difficulty be passed through it. This contraction was produced by a deposition of calcareous matter. The valves of the aorta were united together by a similar deposition, so that the end of the finger could scarcely be introduced into the mouth of the vessel, which was dilated, rough, and thickened to the termination of its arch.—*Essai sur les Maladies du Cœur*, p. 215.

limbs were well nourished, although a considerable extent of the main artery was obliterated, even before it had given off any branches. It is unnecessary to enter into a minute account of the channels through which the blood was conveyed into the limb under these circumstances, because it is not from any particular vessels that the anastomosing branches derive a supply when the main artery is impervious, but from all those ramifications, from whatever source they may arise, which pass in their vicinity. If we consider the course of its branches which are distributed upon the neck and shoulder, we shall at once be convinced, that when the subclavian artery is obliterated at its origin, as in Case XIX.*, these branches will derive a large supply of blood from the carotid and vertebral arteries, and transmit it into their parent trunk, beyond the point of its obliteration. But when the whole extent of the subclavian artery, and consequently the mouths of its branches are obliterated, as in the cases which I have quoted from the *Journal de Médecine*, three series of anastomosing vessels will contribute from above to convey blood into the arm. First, the blood will pass from the superior thyroid, the occipital, and vertebral arteries, into the ascending branches of the inferior thyroid, supra-scapular, cervical, and transverse

* Page 111.

arteries of the neck and shoulder: secondly, it will pass from the ascending branches of these vessels into other branches which extend across the shoulder, through which it will be transmitted into, thirdly, the subscapular and circumflex arteries, which open into the main trunk of the arm. Thus the branches of the subclavian will constitute an intermediate series of vessels, through which the blood will pass from the carotid and vertebral, into the axillary and brachial arteries. The anastomoses of the thoracic with the intercostals will also pour their supply into the axillary artery, when the subclavian is obliterated; and from all these tributary streams a sufficient quantity of blood will pass into the arm for its nourishment and support.

If the anastomosing channels be sufficient to provide for the circulation of the arm when the subclavian artery and the commencement of its principal branches are obliterated, it is evident that the same object will be more readily effected when, the subclavian being pervious, the axillary artery is obliterated. In the latter case, branches of the subclavian artery, namely, the supra-scapular, cervical, and transverse arteries of the neck and shoulder, will derive a direct supply from the subclavian, and transmit it into the sub-scapular and circumflex arteries; so that when the axillary artery is obliterated, only two series of anastomosing branches will be required to carry on

the circulation. The communications between the branches of the subclavian and axillary arteries are so large and numerous, even in their natural state, that if the axillary be tied in the dead subject, and coarse injection thrown into the subclavian artery, it will pass through numerous ostensible anastomoses around the scapula, so as to fill the arteries of the arm.

But when the obliteration of the axillary includes the origins of the subscapular and circumflex arteries, a more extensive series of anastomosing branches will be employed in carrying on the circulation of the limb. The blood will first pass from the supra-scapular, cervical, and transverse arteries of the neck and shoulder, into the ascending branches of the subscapular and circumflex arteries: but, instead of being discharged through the mouths of these vessels into the main artery, it will pass through their descending branches into the profunda brachii, by which it will be conveyed into the brachial artery, or, continuing its course along the descending branches of the profunda, will pass through additional anastomoses into the recurrent radial, ulnar, and interosseous arteries. In this case the subscapular and circumflex arteries will constitute an intermediate series through which the blood will pass from branches of the subclavian into those of the profunda brachii.

The evidence derived from the anatomy of the healthy subject so fully proves that the limb will be supplied with a sufficient quantity of blood for its support when the axillary artery is obliterated, that it is scarcely necessary to adduce cases which more decidedly confirm the fact. Aneurisms of the axillary artery have frequently undergone spontaneous cures, which were attended with the obliteration of that vessel. I have already related a case in which this event took place*, and a second will be detailed in the

* Case XXVII. p. 137. I am informed by Dr. C. H. Orpen, that he has seen a case of aneurism of the subclavian artery, in which the tumour, after enlarging rapidly and beating violently for some months, suddenly lost its pulsation, and gradually subsided into a small compact swelling situated above the right clavicle. The pulsation in the arteries of the arm became imperceptible. The limb continues useless, and in a state of extreme emaciation. It is probable that in this case the loss of power and the diminished nutrition of the arm are owing to the pressure of the tumour upon the cervical nerves, and not to a deficient supply of blood, in consequence of the obliteration of the artery; for in the other instances that I have related in which the subclavian artery was obliterated, the limbs were well nourished, and possessed their natural powers. Van Swieten relates a case in which a man recovered after a wound with a knife in the axilla by which the axillary artery was divided. The arm remained withered and emaciated during the remainder of the patient's life. (Brachium autem illius lateris aridum, et exsuccum, penitus mumiæ fere instar, tota

section on aneurisms arising from wounded arteries. In both instances the arms were well nourished after the cure of the aneurisms: there can be little doubt that the main arteries were obliterated. Similar cases will be found in the works of Sabatier* and Pelletan†. Some years ago a man died in St. Bartholomew's Hospital with an aneurism in the axilla. He refused to submit to an operation,

vita mansit.) It is probable that in this case the axillary plexus of nerves, as well as the artery, was divided.—*Comment. in Aphorism.* BOERHAAV. tom. i. § 161.

† *Médecine Operatoire*, tom. i. p. 364.

‡ *Clinique Chirurgicale*, tom. i. p. 77. In another case of aneurism, Pelletan found the axillary artery obliterated. The tumour was large, and extended as high as the clavicle. It burst, and hæmorrhage took place, two hours before the death of the patient. The coats of the axillary artery, for the extent of about two inches, were remarkably dilated, and from this dilatation the aneurism arose. Immediately below the dilated portion, the axillary artery was contracted, and converted into a ligamentous substance, so that the finest stilet could not be introduced into its cavity. Near the bend of the arm the artery was increased in bulk, and had the appearance of a vessel, but its cavity was still so much contracted, that it was impossible to pass any thing into it. Ibid. tom. ii. p. 93.—A similar case is mentioned by Dr. Monro. A soldier had a large aneurism in the axilla, which extended far down the arm. It burst, and the patient died of a profuse hæmorrhage. Upon dissecting the body, it was found that the axillary artery opened into the sac. The lower part of the artery lay behind the sac, and was quite

because, he said, a similar swelling on the opposite side had cured itself. The second aneurism proved fatal, and dissection verified the man's assertion. The relics of an aneurism, which had undergone a spontaneous cure, were found in the axilla. The main artery was impervious*. Mr. Taunton showed me two preparations, taken from a subject in the dissecting-room, in which both the axillary arteries were obliterated. The left axilla contained a cluster of diseased glands, but there was no morbid appearance in the coats of the artery, or the surrounding parts, which could account for the obliteration of the vessel on the right side. The right arm was injected, and it was found that the supra-scapular communicated by large anastomoses with the sub-scapular artery. These communications were principally situated close to the bone on the infra-spinous fossa of the scapula. A considerable branch of the supra-scapular artery passed underneath the bone, and anastomosed with a branch of the sub-scapular in that situation. A twig, which arose from the axillary artery below the obliterated portion, proceeded

impervious for half an inch; "for, just below where the arterial trunk opened laterally into the sac, the continued trunk of the artery was quite obliterated by the adhesion of its sides."—*Edinburgh Physical and Literary Essays*, vol. iii. p. 196.

* This case was communicated to me by Mr. Abernethy.

upwards, and anastomosed with the supra-scapular artery. The transversalis humeri passed along the basis of the scapula, and contributed to supply the branches of the supra-scapular artery. The aggregate of the anastomosing ramifications was more than equal to the calibre of the brachial artery.

It is not only when the obstruction has taken place gradually, as in the cases which I have mentioned, that the circulation has been carried on after the obliteration of the axillary artery: instances have occurred in which the limb was supplied with blood after the ligature of this vessel in cases of wounds and aneurisms. It is true that in some of these instances mortification of the arm took place, but it did not commence until sufficient evidence existed that the circulation of the limb had been re-established. A careful examination of the cases in which it occurred will, I think, show that the gangrene is to be ascribed to other causes, and not to a deficient supply of blood.

" About seventy years ago, Mr. Hall was called to a man in Cheshire, who had received a very considerable wound just below the axilla, by a sithe, which had divided the brachial artery. The man soon fainted away with the loss of blood, which preserved his life, as no body was near him. Mr. Hall being only accidentally in the neighbourhood, had no needles with him; but as

soon as he arrived, he easily laid hold of the artery with his finger and thumb, till he could procure some thread, which he immediately tied round the vessel and effectually secured it. The man recovered the use of his arm, though he had ever after it a weak and trembling pulse*."

Mr. White has related the case of an officer whose axillary artery was wounded by the stab of a sword. The patient soon fainted, and the hæmorrhage ceased. An unsuccessful attempt was made to secure the mouth of the artery in the wound, by passing a needle underneath it. A needle was then passed round the artery, by introducing it through the skin a short distance above the wound, and including a considerable quantity of the surrounding parts. The ligature was tied and the hæmorrhage ceased. When the patient recovered from the fainting the arm was cold and no pulsation could be felt in its arteries. On the third day the arm was perfectly warm, and the veins were turgid with blood; but on the fourth day gangrene attacked the shoulder, and on the evening of the same day the patient died. When the limb was examined, it was found that the ligature surrounded the axillary artery, which had been completely divided below the circumflex artery of the shoulder: it included also three of the brachial nerves. The axillary vein was

* See BELL *on Wounds*, p. 60. Third edition.

wounded, but not included in the ligature*. In this case the limb had regained its heat on the third day after the ligature of the artery, and the venous circulation was observed to be going on. The occurrence of gangrene, therefore, may with greater probability be ascribed to the ligature of the nerves than of the artery, for it is evident that the limb was supplied with blood.

A case in many respects similar to the above occurred to Desault. In this instance also the sphacelation of the limb cannot be imputed to a deficient supply of blood, but to the extreme debility produced by profuse hæmorrhage, and to the state of the surrounding parts, amongst which the blood had been extravasated so as to produce extensive suppuration and sloughing. A man was wounded in the axilla by a sword: a prodigious quantity of blood was instantly lost: a large tumour rapidly filled the axilla and the man fainted. In two days the whole limb was inflamed: blood oozed from the wound; and the patient suffered severe pain and fever. On the fourth day the fore arm was cold: the skin upon it was of a yellow tint: hæmorrhage recurred: the tumour increased, and was attended with obscure pulsation: the skin which covered it was red and tense. In this state the patient was admitted into the Hotel Dieu on the seventh day after the accident. Desault divided the integuments by an

* *London Medical Journal*, vol. iv.

incision six inches in length, commencing underneath the acromial third of the clavicle, and extending downwards and outwards. The fibres of the pectoral muscle being divided, a great quantity of coagulum, followed by a stream of recent blood, rushed forth, although an assistant firmly compressed the subclavian artery above the clavicle. The operator immediately seized the mouth of the artery and the plexus of nerves with his finger and thumb, and thus commanded the hæmorrhage. An assistant then tied the artery and plexus of nerves which the operator had secured. The mouth of the artery, which had been divided above the origin of the subscapular and circumflex arteries, was then tied by itself, and the nerves being separated from the artery, the ligature applied in the first instance was left as a ligature of reserve. The lower extremity of the wounded artery was secured in a similar manner*. In the evening after the operation an obscure pulsation was observed in the radial artery of the diseased limb, which had in some degree regained its natural heat. The veins on the back of the hand and arm were filled with blood. No doubt existed that the circulation was re-established. On the third day suppuration had

* The artery was secured in this case by passing the ligatures up a silver canula and fastening them at the top by means of a peg of wood, so that they could be tightened when thought necessary.

commenced in the wound, which was filled with dressings: sloughs were observed in the bottom of the axilla. The patient was seized with difficulty in breathing, and on the fourth evening an erysipaltous redness was observed on the fore-arm. On the fifth day the temperature of the limb was diminished: the nails were of a dark colour, and purple spots appeared on the arm. On the sixth day the limb was vesicated and gangrenous, and the patient died*. Additional cases will be mentioned hereafter in which the limb was supplied with blood after the ligature of the axillary artery.

When an aneurism arises from the axillary artery near the commencement of the brachial, and the disease is in its early stage, it is possible to tie the artery between the tumour and the clavicle. But when the tumour is large, or when it arises from the axillary artery near the commencement of that vessel, it will be impossible to perform the operation in this situation: under these circumstances the surgeon will be required to undertake the ligature of the subclavian artery. There are two operations, therefore, which may be required for axillary aneurisms, and the necessity for each is determined by the extent and situation of the disease:—in some cases it may be necessary to tie the axillary:

* *Œuvres Chirurgicales* de DESAULT, par Bichat, tom. ii. p. 553.

—in others the subclavian artery. I shall consider the cases in which each of these operations may be required, and describe the mode in which each is performed.

Axillary aneurisms are rarely met with in that early stage in which it is possible to tie the artery between the tumour and the clavicle. The parts which compose the axilla afford so little resistance, that when the coats of the artery have given way the sac enlarges rapidly: the tumour soon elevates the pectoral muscle, and, by extending underneath it, renders it impossible to tie the artery below the clavicle. It is therefore in those instances in which the disease arises from the upper part of the brachial artery that this operation will generally be required.

Mr. Keate has recorded a case of axillary aneurism which he cured by tying the artery immediately below the clavicle. The patient was a soldier, twenty-five years of age. He was wounded in the hand by a musket ball, and about five weeks afterwards it was necessary to amputate three of his fingers. In five months the stumps were not healed. Matter repeatedly formed near the wrist, and the swelling did not diminish when the matter was evacuated, but successively occupied several parts of the arm. The pulse could not be felt in the arteries of the arm. A circumscribed tumour formed

in the axilla: at first it was scarcely distinguishable from the surrounding tumefaction: it soon became more prominent, and a strong pulsation was felt in it. The apex of the tumour became so thin in a few days that the stream of blood could be distinctly felt to come against the sac *per saltum*. The pulsation disappeared. The tumour became hard, but continued to enlarge. About a fortnight after the time when the pulsation was first observed, the tumour burst, and a small quantity of arterial blood was discharged. The hæmorrhage was restrained by compression. In a few days it recurred, and was stopped by compressing the subclavian artery upon the first rib.—"In this state," says Mr. Keate, "I saw the patient; and however bad the prospect, I determined upon taking up the artery above the diseased and ruptured part in its passage over the first rib. Accordingly, I made an incision obliquely downwards: divided the fibres of the pectoral muscle that lay in my way; and, when I came to the artery, passed a curved blunt pointed silver needle armed double, as I conceived, under the artery, and tied two of the ends. After a careful examination, finding that the artery pulsated below the ligature, I determined on passing another ligature higher up and nearer to the clavicle: I therefore passed the needle deeper, evidently including the artery." The swelling of the arm gradually subsided: the wound suppurated, and the

ligatures were discharged. The arm regained its feeling, and the shoulder and elbow joints the power of motion: the motion of the wrist was destroyed before the operation *.

Pelletan attempted to tie the axillary artery immediately below the clavicle. The aneurism was large and filled the axilla, but a considerable space existed between the tumour and the clavicle. Pelletan proposed detaching the pectoral muscle from the clavicle throughout the whole extent of its origin from that bone, so as to enable him to expose and tie the artery. It was however suggested to him, that by dividing the pectoral muscle the tumour, being deprived of its support, might suddenly burst; and that, instead of dividing the muscle, it would be safer to include some of its fibres together with the artery in the ligature. This proposal was adopted. Pelletan plunged in his needle several times, but was unable to pass it round the artery on account of the depth at which the latter was situated. The operation was therefore abandoned. The sufferings of the patient increased: inflammation of the chest came on; and the man died on the twentieth day after the operation †.

The axillary artery may be tied immediately below the clavicle in the following manner:

The patient being seated in a chair with the

* *London Medical Review and Magazine* for 1801.

† *Clinique Chirurgicale*, tom. ii. p. 49.

shoulders slightly reclined backwards, an assistant is placed behind him ready to compress the subclavian artery against the first rib in the event of hæmorrhage during the operation*. The operator then commences a semilunar incision through the integuments about an inch from the sternal extremity of the clavicle. The wound is to be continued towards the acromion in a curved direction downwards for the extent of three or four inches, so as to terminate near the anterior margin of the deltoid muscle†. This incision will expose the fibres of the pectoral muscle, which are to be divided in the same direction and throughout the whole extent of the external wound. The semilunar flap which is thus formed is then to be raised by dividing the loose cellular membrane which connects the pectoral muscle to the parts underneath it. The pectoralis minor will now be seen crossing the inferior part of the wound; and if the operator pass his finger between the superior margin of this muscle and the clavicle, he will distinctly feel the pulsations of the axillary artery. In this situation one of the cervical nerves,

* For this purpose the assistant should be provided with a hard compress composed of a piece of wood an inch long and half an inch broad, covered with leather, and fixed to the extremity of a key instrument similar to that employed by dentists.

† The incision should not be continued into the space between the deltoid and pectoral muscles, in order to avoid wounding the cephalic vein.

proceeding to form the axillary plexus, lies above, but in contact with, the artery: the other nerves are situated behind the artery. In the dead subject the axillary vein is situated below it; but during life, when the vein is distended, it swells over and conceals the artery. All these parts are connected together by cellular membrane, which is to be separated either by a careful dissection or by lacerating it with a blunt instrument. The artery being exposed, the operator passes a ligature by means of an aneurism needle around it. The ends of the ligature are then to be raised and a finger passed down so as to compress the part surrounded by the ligature. If the artery be included, the pulsation in the aneurism will immediately cease; but it is possible that one of the cervical nerves may have been mistaken for it, since, from their contiguity, they receive a pulsation from the artery. When the surgeon is convinced that the artery is the part surrounded by the ligature, the latter is to be tied, and the wound dressed with slips of adhesive plaster in the usual manner.

When an aneurism arises from the axillary artery at the commencement of that vessel, or when the tumour in the axilla is very large, and extends upwards so as to render it impossible to perform the operation below the clavicle, it will be necessary to tie the subclavian artery. Few operations in surgery can be accomplished with greater

facility upon the dead body than the ligature of the subclavian artery at the point where it emerges from behind the anterior scalenus muscle and lies upon the flat surface of the first rib. When the integuments and platysma myoides are divided at the root of the neck, the artery is merely covered with loose cellular membrane, and the acromial margin of the anterior scalenus muscle is a guide by which the finger may be directed to its precise situation. But in the living subject, when the aneurism is large and extends upwards, it elevates the acromial extremity of the clavicle, so as to diminish the space above that bone at the root of the neck, and render the situation of the artery much deeper than in the natural state of the parts. Under these circumstances it is often extremely difficult and sometimes impossible to pass a ligature underneath the vessel. It is therefore particularly important that this operation be undertaken whilst the tumour in the axilla is small and has not displaced the clavicle. It is always desirable that the operation for aneurism be performed whilst the disease is in its early stage, because the increase of the tumour must be attended with destruction of the surrounding parts, which will render the cure more tedious and uncertain: but in this situation the propriety of operating in an early stage of the disease is more important, for the reasons which I have now mentioned. The reader will be fully satisfied that the displacement

of the clavicle, by the increase of the tumour, will in some instances render it impossible to tie the artery in this situation, when he is informed that Mr. Astley Cooper was compelled to abandon the attempt in a case in which he undertook this operation. "The aneurism was very large, and the clavicle was thrust upwards by the tumour so as to make it impossible to pass a ligature under the artery without incurring a risk of including some of the nerves of the axillary plexus. The attempt was therefore abandoned*."

The operation should, however, be undertaken, if the circumstances of the case demand it, although the clavicle be thrust out of its natural situation, for it is possible by the aid of mechanical inventions to pass a ligature round an artery in a deep and contracted wound. Desault had frequently experienced a difficulty in passing the common aneurism needle underneath deep-seated arteries. He therefore invented an instrument which may be conveniently employed under the circumstances which I am now considering. It consisted of a silver sheath which was straight at one end and bent at the other in a semicircular form. This sheath enclosed a stilet of elastic steel, one extremity of which was perforated by an eye, and was sufficiently long to project beyond the sheath, which

* *London Medical Review*, vol. ii. p. 300.

it accurately filled. The instrument was passed underneath the artery, and when its point had reached the other side of the vessel, the sheath was held firmly in that position, whilst an assistant pressed forwards the elastic stilet, the extremity of which, rising in the bottom of the wound, presented its eye to the surgeon, through which he passed the ligature: the stilet was then drawn back into its sheath and the whole instrument brought from beneath the artery, by which means a ligature was conveyed under the vessel*.

Some improvements have been made in the construction of this instrument, by means of which the ligature may be passed underneath the artery at the same time that the stilet is thrust forwards, so as to obviate the inconvenience of passing the ligature through the eye of the latter in the bottom of a deep and contracted wound. For this purpose, Mr. Henry Earle suggested the advantage of permitting an opening to be left at the back of the sheath, so as to allow the passage of the ligature, which is introduced through the eye of the stilet, before the latter is passed down the sheath. In the instrument recommended by Mr. Watt an opening is also left in the back of the sheath: the stilet consists of two parts: the longer portion is provided with a handle, and is of the same length

* *Œuvres Chirurgicales* de DESAULT, par Bichat, tom. ii. p. 560.

as the sheath, into the curved extremity of which an elastic steel needle, about an inch and a half in length, is introduced, having an eye at one end through which a ligature is passed. By pressing forwards the stilet, the needle is passed underneath the artery and may be drawn out on the opposite side so as to convey a ligature under the vessel *. Various other contrivances have also been recommended for the purpose of conveying ligatures under deep-seated arteries †, but those which I have now described appear to be peculiarly convenient for the purpose, when the wound is so deep and contracted as to render it impossible to pass the ligature with a common aneurism needle.

When the clavicle is much elevated the operator will find it extremely difficult to tie the knot of the ligature at the bottom of the wound, without dragging or elevating the artery. He should, therefore, be provided with two instruments, each composed of a small loop of steel or silver, fixed upon a handle. Each extremity of the ligature being passed through one of these loops and secured by twisting it round the handle of the instrument, the knots may be tightened without introducing the fingers into the bottom of the wound ‡.

* These instruments are described and delineated in Mr. RAMSDEN's *Observations on the Testicle and on Aneurism*, p. 312, 314.

† See ibid, p. 307.

‡ See ibid. p. 309.

Mr. Ramsden succeeded in tying the subclavian artery although the aneurism had thrust the clavicle considerably upwards. This case did not terminate successfully: it is, however, particularly valuable, not only because it exhibits the difficulties which exist in the performance of this operation when the tumour is large and the clavicle displaced, but likewise because it proves that the circulation of the limb was carried on after the subclavian artery was tied. It is interesting also because it is the first case in which the ligature of the subclavian artery was accomplished.

The patient was thirty-two years of age; addicted to excessive intoxication, and possessed an unhealthy and peculiarly anxious countenance. He was admitted into St. Bartholomew's Hospital on the second of November, 1809, with an aneurism in his right axilla of about four months' duration. The prominent part of the tumour was of the size of the half of a large orange. There was also a very considerable enlargement and distention underneath the pectoral muscle and adjacent parts, which prevented the elbow from being brought, by the distance of several inches, into contact with the side. The temperature of both arms was alike, and the pulse in the radial artery of each of them was correspondent. The sufferings of the patient experienced temporary relief from bleeding, but the weight and incumbrance of his

arm soon became more and more oppressive: his nights were again sleepless, and his countenance reassumed the anxiety which had characterized it when he first presented himself for advice. About the sixth day after his admission into the hospital, the pulsation of the radial artery of the affected arm was observed to become more obscure, and soon afterwards it either ceased entirely, or was lost in the succeeding œdema of the fore-arm and hand, both of which became loaded to a great extent. The health of the patient declined, and the progressive elevation of the clavicle, from the increasing bulk of the tumour, was so decidedly creating additional obstacles to any future operation, that a consultation was called as to the propriety of performing the operation, when it was agreed that it should be postponed, under the idea of allowing the greatest possible time for the anastomosing branches to become enlarged, as the tumour did not appear immediately to endanger the life of the patient, from any probability of its bursting suddenly. On the evening of the twelfth day, however, the man complained of more than the usual weariness and weight in the affected limb, and on examining the tumour, a dark spot appeared on its centre, surrounded by inflammation, which threatened a more extensive destruction of the skin. Under these circumstances, the postponement of

the operation was inadmissible: it was accordingly performed the next day, in the following manner:

"The patient being placed upon an operating table, with his head obliquely towards the light, and the affected arm supported by an assistant at an easy distance from the side, I made," says Mr. Ramsden, "a transverse incision through the skin and platysma myoides, along and upon the upper edge of the clavicle, of about two inches and a half in length, beginning it nearest to the shoulder, and terminating its inner extremity at about half an inch within the outward edge of the sterno-cleido-mastoideus muscle. This incision divided a small superficial artery, which was directly secured. The skin above the clavicle being then pinched up between my own thumb and finger, and those of an assistant, I divided it from within outwards and upwards in the line of the outward edge of the sterno-cleido-mastoideus muscle to the extent of two inches. My assistant having now lowered the shoulder, for the purpose of placing the first incision above the clavicle, (which I had designedly made along and upon that bone,) I continued the dissection with my scalpel until I had distinctly brought into sight the edge of the anterior scalenus muscle, immediately below the angle which is formed by the traversing belly of the omo-hyoideus, and the edge of the sterno-cleido-mastoideus; and

having placed my finger on the artery at the point where it presents itself between the scaleni, I found no difficulty in tracing it, without touching any of the nerves, to the lower edge of the upper rib, at which part I detached it with my finger nail for the purpose of applying the ligature. Here, however, arose an embarrassment, which (although I was not unprepared for it) greatly exceeded my expectation. I had learned, from repeatedly performing this operation many years since on the dead subject, that to pass the ligature under the subclavian artery with the needle commonly used in aneurisms would be impracticable. I had therefore provided myself with instruments of various forms and curvatures to meet the difficulty, each of which most readily conveyed the ligature underneath the artery, but would serve me no farther; for being made of solid materials and fixed in handles, they would not allow of their points being brought up again at the very short curvature which the narrowness of the space between the rib and the clavicle afforded, and which, in this particular case, was rendered of unusual depth by the previous elevation of the shoulder by the tumour. After trying various means to overcome this difficulty, a probe of ductile metal was at length handed me, which I passed under the artery, and bringing up its point with a pair of small

forceps, I succeeded in passing on the ligature, and then tied the subclavian at the part where I had previously detached it for that purpose. The drawing of the knot was unattended with pain, the wound was closed by the dry suture, and the patient was then returned to his bed."

The distressing tingling sensation at the ends of the patient's fingers ceased from the time the ligature was applied to the artery. In the evening of the same day he possessed greater facility in placing the affected arm, and was in all respects much more free from pain than previous to the operation. The temperature of both arms appeared equal; and, to the feelings of the patient, the affected arm was warmer than the other. Until the fourth day, his symptoms were very favourable. He slept sufficiently: the tension of the tumour was very much diminished: the œdema of the limb was nearly removed: the discoloured spot in the skin covering the tumour had not increased, and the temperature of both arms was equal. On the evening of the fourth day the discoloured spot in the axilla had extended to the size of a dollar, and there was a little oozing from the crack in its centre. The tension of the tumour was still farther diminished, and the œdema of the fore-arm and hand had entirely subsided. The symptoms of fever were high, and the patient appeared to suffer

oppression at his chest. The temperature continued the same in both arms. On the morning of the fifth day the fever had increased. The sloughing point on the tumour was more distinctly marked at its edge, but had not extended. The wound had a favourable appearance, and was free from pain. The patient complained of great weariness and weight in the affected arm, and laboured under considerable oppression at the chest. The temperature of both arms continued to correspond. About noon, the patient became restless, and betrayed symptoms of aberration of mind. He complained of the weight of the affected arm. His pulse was very rapid and intermittent. The arms were of equal warmth. The slough in the axilla was not more separated. In the evening his pulse was too rapid to be reckoned, and intermitted. He expressed a wish to be raised in his bed. The assistants being unable to place him quite upright, he made an exertion to raise himself. A strong convulsive action took place about the region of the heart, and in an instant he expired.

Upon dissection it was found that the subclavian artery, where the ligature was applied, was only held together by a few shreds of dead matter. Each extremity of the almost divided artery, on being laid open, was found to be already completely consolidated and impervious, and each contained a small deposit

of coagulable lymph, which was closely connected with the internal coat of the vessel. The aneurismal tumour contained about two pints of blood, the greater part of which was in so fluid a state, that it escaped through a small puncture made into the sac. The front of the tumour was covered with a strongly connected substance, bearing some resemblance to a sac, but its posterior and other boundaries were formed merely of those parts, unaltered from their healthy state, with which the effused blood had happened to come in contact*.

In this case the patient appears to have been destroyed by the fever and irritation excited by the operation, and the extent of the disease in the axilla. The state of the temperature of the limb clearly proved that its circulation was carried on after the ligature of the subclavian artery, and the condition of the vessel at the part where the ligature was applied showed that the process of adhesion was accomplished in its extremities on the fifth day. These facts afforded encouragement for repeating the experiment in a case where the aneurism was small, and the operation could be accomplished with facility and less distress to the patient.

In the year 1811, the subclavian artery was tied in the London Hospital in a case of axillary

* See RAMSDEN *on the Testicle, and on Aneurism*, p. 276.

aneurism. Sir William Blizzard informs me that he accomplished the operation with the greatest facility, and found no difficulty in passing the ligature underneath the artery with a common aneurism-needle. A single ligature was applied. For two days after the operation his symptoms were so favourable, that great hopes were entertained of the patient's recovery. The limb retained its natural temperature, and the blood was observed to circulate freely through its veins; but the patient, who was advanced in years, and much reduced in strength, died on the fourth day.

It has happened, in an attempt to perform this operation, that one of the cervical nerves was mistaken for the artery, and tied instead of it*. In most operations for aneurism the pulsation of the artery enables the surgeon to ascertain decidedly whether it be the part upon which his finger is placed; but the cervical nerves are situated so close to the subclavian artery, where it passes over the first rib, that it communicates a pulsation to them. From this cause, when the wound is deep and

* "This was the case in an attempt which I once saw made to tie the artery, and in which one of the cervical nerves, affected by the pulsation of the artery, was mistaken for it, and tied, so that the aneurism soon afterwards burst, and a fatal hæmorrhage arose."—Cooper's *Surgical Dictionary*, art. Aneurism, p. 122. Second edition.

contracted, one of the nerves is liable to be mistaken for the artery. It has also occurred, in the operation for aneurism, that the surgeon was unable to discover the slightest pulsation in the artery, although it was exposed, and in contact with his finger. In a case of inguinal aneurism, for which I saw the external iliac artery tied, the operator was unable to feel a pulsation in the artery when it was exposed, and his finger and thumb in contact with it. He was, however, confident from its situation that the substance which he felt was the vessel: it was accordingly tied, and the result of the operation proved that he was correct. Deschamps made a similar observation in several operations *. Should the pulsation of the vessel be imperceptible in an attempt to tie the subclavian artery, it will be difficult to distinguish the artery from a nerve, and the success of the operation will depend upon a knowledge of the relative situation of the vessel and surrounding parts.

The operator should therefore be fully aware, that when the subclavian artery has emerged from behind the anterior scalenus muscle, it passes obliquely over the flat surface of the first rib, with which it is in immediate contact. The cervical nerves are situated above and a little behind the

* *Obs. sur la Ligature des Artères*, &c. p. 49.

artery: the subclavian vein passes before it and underneath the clavicle. If the finger be passed down the acromial margin of the anterior scalenus muscle, the artery will be found in the angle formed by the origin of that muscle from the first rib.

The operation may be performed in the following manner:

The patient being seated in a chair, or placed upon a table in a horizontal position, with the shoulder of the diseased side drawn downwards as much as possible, the operator divides the skin immediately above the clavicle, from the external margin of the clavicular portion of the mastoid muscle, to the margin of the clavicular insertion of the trapezius*. The edges of this incision being separated, the platysma myoides will be exposed, and its fibres are to be carefully cut through, so as to avoid wounding the external jugular vein, which will be found immediately under them, near to the middle of the incision. When this vein is discovered, it is to be detached

* Some surgeons recommend in this operation that the clavicular portion of the mastoid muscle should be detached from its origin. I am not aware of any advantage which can be derived from this practice, if it be intended to tie the artery on the acromial side of the anterior scalenus muscle. It is unnecessary, because it will not increase the space for passing the ligature underneath the vessel in that situation.

from the surrounding parts, and drawn towards the shoulder with a blunt hook. The operator then divides with his knife, or separates with his finger, the cellular membrane in the middle of the wound, until he arrives at the acromial margin of the anterior scalenus muscle. He passes his finger down the margin of this muscle, until he reaches the part where it arises from the first rib, and in the angle formed by the origin of the muscle from the rib, he will feel the artery. The ligature is now to be passed underneath the artery either with a common aneurism-needle, or that recommended by Desault. When the operator is satisfied by raising the ends of the ligature, compressing the part which it surrounds, and observing that the pulsation in the aneurism ceases, that the artery is the part included in the ligature, the latter is to be tied, and the wound closed with slips of adhesive plaster. When the patient is placed in bed, the neck is to be slightly bent towards the diseased side, so as to retain the edges of the wound in contact.

When the shoulder and clavicle are thrust upwards by an axillary aneurism, so as to render it impossible to pass a ligature underneath the subclavian artery on the acromial side of the scalenus, it may be proper to tie the vessel on the tracheal

side of that muscle. It may also be necessary to tie the vessel in this situation in a case of aneurism arising from the subclavian artery near the shoulder, in which the tumour is small, and does not extend beyond the tracheal margin of the scalenus. This operation, however, will rarely be applicable to aneurisms of the subclavian artery, because the tumour generally occupies so much of the space above the clavicle as to render it impossible to tie any part of that vessel.

Aneurisms arising from the arch of the aorta, or the arteria innominata, generally proceed upwards, and appear at the root of the neck, so that they are very liable to be mistaken for aneurisms of the carotid and subclavian arteries. I have mentioned a case, in a former part of this treatise, in which it was proposed to tie the carotid artery for an aneurism which dissection proved to originate from the arteria innominata and the arch of the aorta. In this case the stricture formed by the resistance of the sternum and clavicles was so considerabe, that it appeared possible to tie the artery between the sac and the chest*. Mr. Allan Burns has related a case of aneurism of the aorta and arteria innominata which ascended above the clavicle, and appeared so decidedly to arise from the subclavian

* See page 90.

artery, that an operation was suggested*. When an aneurism arises from the arch of the aorta or the arteria innominata the tumour generally appears externally near the sternum, in which situation it can seldom be mistaken for an aneurism of the subclavian artery. I have, however, seen two cases of aneurisms arising from the aorta and arteria innominata, in which the tumour projected above the acromial half of the clavicle; and in the case related by Mr. Allan Burns, "the first appearance of the sac was nearer to the acromion than the sterno-mastoid muscle, at a point where no one would expect a tumour to be present, which had worked its way from within the chest†." These circumstances render it of the greatest importance that the surgeon should be fully convinced, before an operation be undertaken in a case of aneurism situated above the clavicle, that the disease does not arise from the arch of the aorta or the arteria innominata.

The operation of tying the subclavian artery on the tracheal side of the scalenus is particularly hazardous, on account of the important parts with which this portion of the artery is connected. The

* *Surgical Anatomy of the Head and Neck*, p. 32. plates I. & II.

† Ibid. page 42.

par vagum and the phrenic nerve pass before the artery in this situation, and the lower cervical ganglion of the sympathetic nerve lies behind it. On the right side the recurrent nerve passes round the artery, and on the left side it runs between the artery and the œsophagus. The subclavian vein is situated immediately underneath the clavicle, anterior to the artery, and in its collapsed state sinks below that vessel; but when distended, it swells over, and conceals the artery. On the left side the thoracic duct descends over the artery to open into the subclavian vein. The artery lies in immediate contact with the pleura, and in passing a ligature underneath the vessel, that membrane will be very liable to be lacerated. Close to the margin of the scalenus the subclavian gives off the inferior thyroid and internal mammary arteries, and a little nearer the heart the vertebral artery originates. If the ligature be applied close to the commencement of these large branches, the circulation through them will most probably prevent the formation of a plug in the vessel; and under these circumstances the recent adhesion at the extremity of the artery will be liable to be forced asunder by the powerful impulse of the circulating blood so near to the heart*. On this account it is desirable that the ligature should

* See the observations on this cause of secondary hæmorrhage at p. 210.

be applied nearer to the heart than the origin of the vertebral artery.

The subclavian artery may be tied on the tracheal side of the scalenus in the following manner, and upon the dead subject the operation is accomplished with facility:

A horizontal incision, three inches in length, is to be made through the skin and platysma myoides immediately above the sternal extremity of the clavicle. A director is to be passed underneath the clavicular origin of the mastoid muscle, which is to be divided. The operator separates with his finger, or the handle of his knife, the cellular membrane in the bottom of the wound, until he arrives at the anterior scalenus muscle. He then traces the tracheal margin of that muscle, until he feels the artery passing behind it. The inferior thyroid and the vertebral arise from the subclavian artery near to the margin of the scalenus: it will therefore be prudent to trace the subclavian, and apply the ligature nearer to the heart than the origin of the vertebral artery. In passing the aneurism-needle underneath the artery, the operator must be extremely cautious to avoid lacerating the pleura, upon which the artery is situated.

Another mode in which the right subclavian artery may be tied consists in detaching both the sternal and clavicular origins of the mastoid

muscle, and tracing the carotid artery to its origin from the arteria innominata. At this point the subclavian artery will be found, and may either be tied in that situation, or a little nearer to the scalenus.

It has been proposed to tie the arteria innominata in cases of aneurism of the subclavian artery. The facts which I have mentioned in the commencement of this section, and in that on carotid aneurism, prove that the circulation of the brain and arm will be carried on after the obliteration of the carotid or subclavian arteries; and Mr. Allan Burns found, that when the arteria innominata was tied in the dead subject, "coarse injection impelled into the aorta, passed freely by the anastomosing branches into the arteries of the right arm, filling them and all the vessels of the brain completely*." Both carotid arteries have been repeatedly tied in brutes at the same time, without the slightest apparent derangement of the functions of the brain; and from this fact it is probable that the supply of blood through one carotid and vertebral might be cut off with equal success. There is little doubt, therefore, that the brain and arm would

* Burns, *on the Surgical Anatomy of the Head and Neck*, p. 31.

be supplied with a sufficient quantity of blood, although the arteria innominata were obliterated.

In the dead subject, when the head is bent backwards, and the sternal portions of the mastoid and the sterno-thyroideus and the sterno-hyoideus muscles are divided, it is by no means difficult to trace the carotid artery to its origin from the arteria innominata, and to pass a ligature underneath the latter. But upon the living body this operation will be extremely difficult and perilous. When the head is bent backwards, the arteria innominata is drawn upwards into the root of the neck, but it will be impossible for the patient to preserve this position during a painful operation. The inflammation excited amongst the important parts which are situated at the upper part of the chest may produce the most dangerous consequences, and the force of the circulation so near to the heart will be liable to lacerate the adhesion at the extremity of the artery, unless a plug exist in its cavity. It is difficult also to imagine a case for which the ligature of the arteria innominata can be required, because in most instances it will be equally practicable to tie the subclavian artery on the tracheal side of the scalenus.

The ligature of the arteria innominata, or of the subclavian artery on the tracheal side of the sca-

lenus, must be regarded as peculiarly hazardous. I have thought it proper, however, to treat of these operations, because, under particular circumstances, a surgeon may conceive it his duty to undertake them.

SECTION VII.

ON BRACHIAL, RADIAL, AND ULNAR ANEURISMS.

ALTHOUGH the operation of tying the brachial artery was accurately described by some of the most ancient writers on surgery*, and cases were recorded in which it had been successfully performed†, it was not until the latter end of the last century that the channels were demonstrated by which the circulation of the limb would be carried on after the obliteration of this vessel. Even in the times of Heister‡, Sharp‖, and Gooch§, it was conceived that in most instances in which an aneurism in the arm was cured by an operation, the brachial artery divided into

* ŒTIUS, serm. iv. tetr. iv. cap. 10.—PAULUS, *de Re Medica*, lib. iv. cap. 37.

† WISEMAN, book i. chap. xvi. obs. v.—book v. chap. ii. obs. vi.—PURMANUS, *Chirurgia Curiosa*, p. 212.—SAVIARD, *Observations in Surgery*, obs. vii.—RUYSCH, *Opera, Obs. Anatomico Chirurgicæ*, tom. i. p. 4.—HEISTER'S *Cases*, obs. xlviii. and the cases in which Teichmeyer and Trew succeeded in curing brachial aneurisms by compressing the denuded artery. See LAUTH. *Collect. Script. de Aneurismat.* p. 549.

‡ See HALLER, *Disputationes Chirurgicæ*, tom. v. p. 149.

‖ *Treatise on the Operations of Surgery*, p. 210.

§ *Practical Treatise on Wounds*, &c. p. 180.

the radial and ulnar above the tumour, and that when one of these branches was tied the circulation of the limb was carried on by the other. Mollinelli and White* proved that the anastomoses between the branches of the brachial and the recurrent radial and ulnar arteries, would supply the fore-arm with a sufficient quantity of blood for its support when the brachial artery was obliterated. Mr. White injected and dissected the arm of a woman who died fourteen years after the ligature of the brachial artery for the cure of an aneurism at the bend of the arm. The injection passed into the fore-arm through a few large and tortuous communications between the branches of the brachial and the recurrent radial and ulnar arteries. The ramus anastomoticus was the principal branch of the brachial artery which contributed from above to carry on the circulation of the limb.

The channels through which the branches of the brachial communicate with the arteries of the fore-arm may be demonstrated by the injection of a healthy limb. They are formed by the anastomoses of the branches of the profunda brachii and of the ramus anastomoticus with the recurrent radial, ulnar, and interosseous arteries. If the brachial

* *Cases in Surgery*, p. 139.—White refers to Mollinelli's case in the *Act. Bonon.* vol. i. part II. p. 72.

artery be tied above the origin of the ramus anastomoticus, the circulation will be carried on through the anastomoses of the profunda with the recurrent branches of the arteries of the fore-arm. If the ligature be applied above the origin of the profunda, the ascending branches of this vessel will obtain a supply from the circumflex and subscapular arteries, which will either be transmitted into the brachial through the origin of the profunda, or will pass through descending branches of the profunda into the recurrent radial, ulnar, and interosseous arteries. If the commencement of the profunda be obliterated, its branches will constitute a third series of anastomosing channels, through which the blood will pass from the circumflex and subscapular arteries into branches which open into the vessels of the fore-arm. By this arrangement of the anastomosing vessels the circulation of the arm is provided for when any portion of the brachial artery is obliterated. Pelletan relates a dissection in which he found the whole extent of the brachial artery impervious*. In this case the three series of anastomosing vessels which I have mentioned must have been employed in carrying on the circulation of the limb.

Those morbid alterations in the coats of arteries which predispose to the formation of aneurism, are

* *Clinique Chirurgicale*, tom. ii. p. 93.

rarely met with in the brachial artery or its branches. In very old persons a deposition of calcareous matter is sometimes found in the coats of these vessels, but I have never seen an aneurism in the arm which was not produced by accidental violence; and in most of the cases upon record in which the disease was supposed to arise from a morbid condition of the vessel, the commencement of the aneurism may be traced to some violent exertion by which the coats of the artery were suddenly torn asunder*. It is therefore in

* The only case that I have met with upon record in which it was proved by dissection that an aneurism at the bend of the arm was attended with those morbid changes in the coats of the artery which predispose to the formation of aneurism, is related by Pelletan. Pelletan tied the brachial artery in a large aneurism at the bend of the arm. Hæmorrhage took place on the tenth day, and reduced the patient so much, that he died on the fourth day afterwards. Upon dissection it was found that a deposition of calcareous matter had taken place in the brachial artery, where it passes under the tendinous expansion of the biceps. A large fissure existed in the coats of the vessel throughout the whole length of that part in which this deposition had taken place.—*Clinique Chirurgicale*, tom. ii. p. 4. Scarpa quotes two cases of brachial aneurism from Paletta and Flajani, as instances in which the disease arose from an internal cause, but in neither of these cases was the condition of the coats of the vessel ascertained by dissection. In one of them the disease followed "a crash in the arm, as if a sinew had burst;" and in the other it commenced after lifting a heavy weight, by which the muscles

wounds, and aneurisms arising from wounds, that the ligature of the brachial artery will generally be required.

The formation of an aneurism is not an unfrequent consequence of a wound of the brachial artery at the bend of the arm in the operation of venesection. When the blood is injected into the surrounding parts so as to constitute a diffused aneurism, it will be necessary to cut down to the

of the arm were violently sprained.—*Treatise on Aneurism*, WISHART'S *Translation*, p. 175, 177. In the first of these cases it is not mentioned whether violence was employed at the time the vessel gave way, but in the latter it is evident that the coats of the artery were lacerated by violent extension. Although a morbid condition of the vessel almost invariably precedes the formation of aneurisms which are imputed to violent extension of the limb, it sometimes, though rarely, happens that the coats of a healthy artery are torn asunder. I believe, however, that the degree of violence in most of these instances will be sufficient to lacerate the surrounding parts as well as the artery; for the elasticity of a healthy artery, in a longitudinal direction, renders it peculiarly extensible. I have examined a preparation in which the brachial artery was suddenly torn across by a violent fall. The formation of a diffused aneurism was the consequence. The whole circle of the artery was as cleanly divided as if it had been cut across with a knife: its coats were perfectly healthy. A similar case is related by Saviard.—*Observations in Surgery*, obs. vii. Pelletan says, that he has known more than one instance in which the formation of an axillary aneurism was the consequence of violent attempts to reduce dislocated shoulders.—*Clinique Chirurgicale*, tom. ii. p. 95.

artery, and to tie both of its extremities close to the wound in its coats. But when the tumour is circumscribed, the case is similar to an aneurism arising from a morbid condition of the coats of the vessel, and may in the same manner be cured by the ligature of the artery at a distance from the disease*.

The operation of tying the brachial artery in the middle of the arm may be performed in the following manner:

The surgeon divides the integuments along the ulnar† margin of the biceps muscle, by an incision two inches and a half in length. The thin fascia which surrounds the arm will thus be exposed, and must be cautiously divided in the direction of the external wound. The artery lies immediately under the fascia, close to the margin of the biceps. The median nerve is situated on the ulnar side of the artery, which lies between its two venæ comites. The internal cutaneous nerve is also situated under the fascia in the middle of the arm, and lies on the ulnar edge of the median nerve. The cellular membrane which connects

* See the section on Aneurisms arising from Wounded Arteries.

† The terms *radial* and *ulnar* are employed by Dr. Barclay in his Anatomical Nomenclature to designate what, in common language, are vaguely denominated the outside and the inside of the arm.

these parts is to be divided until the coats of the artery are fairly exposed. This part of the operation will be effected with facility, if an assistant compress the artery above the wound so as to stop the circulation through it, and render it in some degree flaccid. The point of an aneurism-needle is then to be introduced close to the ulnar, and brought out on the radial side of the artery, so as to avoid including the median nerve, or the veins which accompany the artery. The ligature, which is in this manner conveyed under the artery, being tied, the wound is to be closed with short slips of adhesive plaster. Circular bandages are to be avoided, and the limb is to be placed in a bent position upon a soft pillow.

The brachial generally divides into the radial, ulnar, and interosseous arteries at the bend of the arm. It sometimes happens, however, that one of these branches arises from the brachial artery nearer the axilla. When the ulnar artery is the seat of this variety, it has constantly been observed to emerge from underneath the fascia, and take a superficial course down the arm. But when the radial arises near the axilla, it in most instances accompanies the ulnar artery underneath the fascia until it arrives at the bend of the arm, when it passes to the opposite side of the limb. It is necessary that a surgeon should be acquainted with these

varieties, because from a wound of one of these branches an aneurism may be produced which will require a peculiar mode of treatment. If an aneurism arise from the branch which runs superficially, and the artery can be felt above the tumour immediately under the skin, it will be proper to expose and tie it in that situation. But if, in an attempt to perform the operation of tying the brachial artery in the usual manner in the middle of the arm, the operator discovers two arteries instead of one running close to each other underneath the fascia, it will be doubtful by which of these vessels the tumour is supplied. Under these circumstances one of the vessels may be compressed, so as to ascertain the effect produced upon the tumour by suspending the circulation through that channel. If the pulsation cease, it is evident that the disease is supplied by this vessel: if the pulsation continue, it is equally certain that the tumour arises from the other branch, upon which the ligature must therefore be applied. This mode of operating is unquestionably preferable to that of including both the arteries in a ligature.

When an aneurism arises from the radial, ulnar, or interosseous arteries close to the bend of the arm, the disease may be cured by the ligature of the brachial artery. But when an aneurism of

the radial or ulnar arteries is situated in the middle of the fore-arm, or at the wrist, it will be necessary to tie the vessel from which it arises near to the tumour. The recurrent circulation through the large inosculations between the radial and ulnar arteries in the palm of the hand, will be sufficient to continue the disease if the artery be tied at a distance from the tumour; for the blood which enters from the inferior extremity of the vessel will pass through the sac into branches which originate from the artery between the tumour and the ligature. The artery should therefore be tied as near as possible to the aneurism, so that the blood which enters the latter from the lower extremity of the vessel, being unable to pass forwards, may coagulate in the sac. It has been recommended to tie the artery both above and below the sac in aneurisms of the radial or ulnar arteries. This practice can only be necessary when the ligature has been applied to the superior portion of the artery at a distance from the tumour. I have seen an aneurism, arising from a wound of the radial artery near the wrist, which was cured by tying the superior portion of the vessel near to the tumour.

The radial artery may be tied two or three inches below the bend of the arm, by making an

incision through the integuments on the ulnar margin of the supinator radii longus muscle. The fascia of the arm being exposed, it is to be divided to the extent of two inches, or two inches and a half, so as to allow sufficient space for the separation of the supinator radii longus from the flexor carpi radialis. The tendon of the pronator radii teres passes under these muscles: the artery lies upon it and the flexor longus pollicis. A branch of the musculo spiral nerve is situated on the radial side of the artery, which is also accompanied with one, and sometimes with two veins. The coats of the artery must be fairly exposed, so as to enable the operator to pass the ligature under it without including the nerve or veins.

Below the middle of the arm the radial artery is situated more superficially, and its pulsations can be distinctly felt. It may be tied by dividing the integuments on the radial side of the tendon of the flexor carpi radialis. The branch of the musculo spiral nerve leaves the artery, and passes under the supinator radii longus a little below the middle of the fore-arm.

The ulnar artery may be tied above the middle of the fore-arm, by making an incision on the radial margin of the flexor carpi ulnaris muscle. The fascia which surrounds the arm being divided,

the fibres which form the flexor carpi ulnaris are to be separated from the flexor digitorum sublimis. The artery will be found between these muscles, rather underneath the edge of the flexor sublimis and upon the flexor profundus digitorum. It is accompanied with a vein, and the ulnar nerve: the latter lies upon the ulnar side of the artery.

Below the middle of the arm the course of the ulnar, like that of the radial artery, is more superficial. It lies between the tendons of the flexor carpi ulnaris and the flexor profundus digitorum. It retains the same situation with regard to the ulnar nerve as in the upper part of the fore-arm.

When the ulnar artery arises from the brachial above the elbow, it runs above the fascia, and may be tied with facility in any part of its course.

SECTION VIII.

INGUINAL ANEURISM.

It was known that the limb would be supplied with a sufficient quantity of blood for its nourishment and support, when the femoral artery was obliterated above the origin of the profunda, long before it was conceived that inguinal aneurisms might be cured by the ligature of the external iliac artery.

Severinus relates the history of an immense aneurism in the groin, which was cured in consequence of the sphacelation of the whole tumour*. Gavina communicated to Guattani a case of inguinal aneurism which was attacked with gangrene. An immense quantity of sloughs, consisting of the aneurismal sac and adjacent parts, were detached, and the patient lived five weeks after the destruction of the femoral artery above the origin of the profunda, when the powers of his constitution proved insufficient to repair the extensive ulcer which remained in his groin. Upon dissection the external iliac artery was found very much contracted, and filled with a firm plug of coagulum†. In a similar case recorded by Dr. Clarke, in the year

* *De Recondita Natura Abscessuum*, p. 199.

† Guattani, *de Externis Aneurismatibus*, hist. xvii. p. 63.

1784, the tumour having increased to the size of a melon, was attacked with gangrene, and burst. The sloughs had separated completely, when the patient was seized with an acute disease in his chest, of which he died *. Upon dissection it was found that the external iliac artery was filled with a firm plug. Maximini having laid open an aneurism which extended from the os pubis to the crista of the ilium, Guattani applied graduated compresses to the mouth of the artery, and retained them in that situation by bandages, so as to prevent hæmorrhage. When the dressings were removed on the thirteenth day, the artery was closed, and in a few months the wound was healed †. In another case of inguinal aneurism related by Guattani, the tumour, pain, and fever were at first diminished by bleedings and compression. After a month the tumour suddenly increased, and proved fatal by bursting into the cellular membrane of the pelvis and thigh. Upon dissection it was found that the external iliac artery was lacerated on its posterior surface, and was stretched over the aneurismal tumour, which was situated between it and the bones of the pelvis. The calibre of the femoral artery was very much contracted, and the popliteal artery was obliterated. Guattani was convinced that the pressure of the

* Duncan's *Medical Commentaries*, vol. iii. decad. 2. p. 326.

† Guattani, *de Externis Aneurismatibus*, hist. xv. p. 50.

aneurism prevented the blood from passing into the femoral artery, and that the circulation of the limb was carried on through collateral channels. To determine this point more satisfactorily, he tied the external iliac artery, and found that coloured water injected into the internal iliac escaped freely from the arteries at the ancle. Guattani repeated the experiment after tying the femoral and popliteal arteries, and found that he could force the coloured water from the internal iliac into the arteries of the foot*.

The channels through which the circulation of the limb is carried on when the external iliac artery is obliterated, are the anastomoses between the branches of the internal iliac, namely, the gluteal, ischiadic, internal pudendal, and obturatrix, with the circumflex branches of the profunda, the external pudendal, epigastric, and circumflex iliac arteries. The communications between these vessels are so large and numerous, that when the external iliac is tied in a healthy subject, fine injection will pass from the internal iliac into the femoral artery. If the obturatrix arise from the epigastric, it will derive a supply of blood from its anastomoses with the branches of the internal pudendal, the ischiadic, and the circumflex branches of the profunda. The epigastric and circumflex iliac may also obtain a supply from

* GUATTANI, *de Externis Aneurismatibus*, hist. xvi. p. 57.

their anastomoses with the internal mammary, the inferior intercostals, the lumbar, and sacral arteries. Under these circumstances, if an aneurism be situated below the origin of the epigastric, a stream of blood will enter the femoral artery above the tumour, after the ligature of the external iliac, but this stream will not be sufficient either in quantity or in force to continue the disease. The femoral artery will contract in consequence of the diminution of the stream which passes through it, and the mouths of the epigastric and circumflex iliac will either become obliterated, or the blood will pass from one of these vessels into the other across that portion of the femoral artery which is situated between them*. If the femoral

* I have examined a preparation which was taken from a patient who died in the third week after the external iliac artery had been tied for an inguinal aneurism. The ligature was applied about half an inch below the origin of the internal iliac. From that part the cavity of the artery downwards contained a firm plug, which terminated a little above the origin of the epigastric and circumflex iliac arteries: another plug commenced at the mouth of the aneurismal sac in the groin, and extended upwards nearly to the origin of the epigastric and circumflex iliac arteries, so that between these two plugs a small portion of the artery preserved its cavity. From this portion of the vessel which preserved its cavity the epigastric and circumflex iliac arteries arose, and I conceive that the circulation through these vessels must have been carried on by the passage of the blood from one to the other across that portion of the main artery which was situated between the two plugs.

be obliterated below the origin of the profunda, the blood which enters the trunk through the epigastric and circumflex iliac arteries, after the ligature of the external iliac, will pass into the profunda, and through its descending branches into the articular arteries of the knee, so that a portion of the trunk will continue pervious between the part obliterated by the ligature and that in which the aneurism was situated*. If the origin of the profunda be obliterated, three series of anastomosing vessels will be engaged in carrying on the circulation of the limb. The blood which passes from the branches of the internal iliac into the circumflex branches of the profunda, instead of being discharged through the mouth of the latter into the femoral artery, will be conveyed through the descending or perforating branches of the profunda into the articular arteries of the knee. The branches of the profunda, when the mouth of this vessel is impervious, will therefore constitute an intervening or third series of anastomosing channels, through which the blood will pass from the internal iliac into vessels which arise from the inferior trunks of the limb†.

* This arrangement existed in Mr. Astley Cooper's second dissection, which is quoted at page 404 of this Treatise.

† In one of Mr. Abernethy's patients, who lived eight days after the ligature of the external iliac artery without any alteration being observed in the state of the limb, " the arteria

Mr. Astley Cooper has published an account of the dissection of two limbs, in which he injected and traced the channels by which the circulation of the limb was carried at different periods after the ligature of the external iliac artery. The first patient died ten weeks and six days after the operation, in consequence of the bursting of an aneurism at the bifurcation of the aorta. Five aneurisms were found in the limb; namely, one at the origin of the arteria profunda; a second in the middle of the thigh, where the artery pierces the tendon of the triceps, which aneurism was of large size, and was that for which the operation

profunda was filled with coagulated blood, and had become reduced to less than the natural size."—*Surgical Observations, on Aneurisms*, p. 248. Second edition. In Mr. Astley Cooper's second dissection, to which I have referred in the last note, although the femoral artery was pervious between the origins of the epigastric and the profunda, there can be no doubt that the circumflex and perforating branches of the profunda were the principal channels through which the circulation of the limb was carried on, for the femoral and popliteal arteries were obliterated from the origin of the profunda to the commencement of the tibial and fibular arteries. Guattani found the femoral artery very much contracted, and was convinced that it was rendered impervious by the pressure of an aneurism in the groin: in the ham it was so much contracted, that it would with difficulty admit one of Anel's probes. There can be little doubt that in this instance also the branches of the profunda were the channels that transmitted the blood through the thigh from the arteries of the pelvis into those of the leg.—See GUATTANI, *de Externis Aneurismatibus*, hist. xvi. p. 57.

was performed; a third aneurism was situated in the ham, and between the popliteal and femoral arteries there were two smaller aneurisms. " Upon endeavouring to ascertain the mode in which the blood took its course through the limb, it was found that the femoral, tibial, and fibular arteries were still open, and that the blood was conveyed into the femoral artery by the following anastomoses. The internal pudendal artery formed several large branches upon the side of the bulb of the penis, and these branches freely communicating with the external pudendal artery, had determined the blood into that artery, and by this channel into the femoral; the lateral sacral artery also sent a branch on the iliacus internus muscle into the femoral artery, and the ilio lumbar artery freely communicated with the circumflex iliac, so that by these three routes the blood found direct ingress to the femoral artery. Numerous branches of arteries also passed from the lateral sacral to the obturatrix and epigastric arteries, the obturatrix in this case having its origin from the epigastric. Beside these arteries, a free communication existed between the arteria profunda and circumflex arteries, with the branches of the internal iliac; first, the gluteal artery sent a branch under the gluteus medius muscle to the external circumflex artery; secondly, the ischiadic artery gave two sets of branches of communication, one upon

the gluteus maximus muscle to the arteria profunda, and another upon the sciatic nerve to the internal circumflex artery; the internal pudendal artery also sent a branch of communication to the internal circumflex; lastly, the obturatrix freely communicated with the internal circumflex."

In Mr. Cooper's second case, the external iliac artery was tied on account of a large femoral aneurism situated above the tendon of the triceps. The patient survived the operation nearly three years. The anastomosing channels were much larger and less numerous than in the former dissection. The external iliac and femoral arteries were obliterated, excepting about an inch of the femoral artery just below Poupart's ligament, which still remained open, and continued to convey a portion of the blood, but below this part it had become simply a ligamentous cord. The internal iliac artery sent first a very large artery of communication to the epigastric and obturatrix artery, so that the epigastric was supplied with blood from the internal iliac; secondly, the internal iliac sent an artery of communication upon the sciatic nerve to the internal circumflex artery: the gluteal artery gave a large branch to the origin of the profunda: lastly, the internal pudendal artery largely anastomosed with the obturatrix: the obturatrix, therefore, in this case, sprang from two new sources, viz. from the internal iliac, and

from the internal pudendal artery, and the obturatrix thus formed sent two branches of communication to the internal circumflex artery. The arteria profunda was in this case supplied from two sources—directly from the gluteal—and more indirectly from the internal circumflex, by the obturatrix and ischiadic arteries*.

In this case a portion of the femoral artery between the part obliterated by the ligature, and that in which the aneurism existed, retained its calibre. The blood entered this portion of the femoral artery through the epigastric and circumflex iliac arteries, and passed out of it through the profunda. The blood which entered the ascending branches of the profunda from the gluteal, ischiadic, and obturatrix arteries, instead of being discharged into the femoral artery through the mouth of the profunda, passed down the perforating branches of the latter into the articular arteries of the knee.

Inguinal aneurisms were regarded as incurable until Mr. Abernethy performed the operation of tying the external iliac artery in the year 1796. Although Mr. Abernethy's two first cases terminated unsuccessfully, they fully proved that the limb was amply supplied with blood after the

* *Medico-Chirurgical Transactions*, vol. iv. p. 425. plate v.

ligature of the external iliac artery, and thereby they afforded encouragement for the repetition of the operation, the benefits of which are now established by numerous instances in which it has been successfully performed.

In the first instance, Mr. Abernethy was urged to tie the external iliac artery by the impulse of the moment, for the death of the patient would otherwise have been inevitable. The right femoral artery was tied for the cure of an aneurism in the calf of the leg in a man who was also afflicted with an aneurism of the left femoral artery. The femoral aneurism increased so rapidly, that about five weeks after the first operation it was necessary to tie the artery in the groin. Every thing, with respect both to the state of the limb and the patient's general health, went on well after this operation, until the fifteenth day, when the upper ligature separated, and the blood gushed in a full stream from the open extremity of the vessel. The bleeding was restrained by pressure, whilst Mr. Abernethy proceeded to tie the artery above Poupart's ligament.

" I first made an incision," says Mr. Abernethy, " about three inches in length, through the integuments of the abdomen, in the direction of the artery, and thus laid bare the aponeurosis of the external oblique muscle, which I next divided from its connexion with Poupart's ligament, in the direc-

tion of the external wound, for the extent of about two inches. The margins of the internal oblique and transversalis muscles being thus exposed, I introduced my finger beneath them for the protection of the peritoneum, and then divided them. Next with my hand I pushed the peritoneum and its contents upwards and inwards, and took hold of the external iliac artery with my finger and thumb, so that I was thus enabled to command the flow of blood from the wound. It now only remained that I should pass a ligature round the artery and tie it; but this required caution, on account of the contiguity of the vein to the artery. I could not see the vessels; but I made a separation between them with my fingers. Having, however, only a common needle with which to pass the ligature, I several times withdrew the point, from the apprehension of wounding the vein. After having tied the artery about an inch and a half above Poupart's ligament, I divided that part, and thus laid the new and the former wound into one."

No perceptible alteration occurred in the limb after this second operation. On the fifth day a hæmorrhage of arterial blood took place in such quantity, that there was no doubt but that it arose from the principal artery: it was stopped by the application of compresses and bandages. The strength of the patient, which was considerably

reduced by his previous sufferings, gradually declined. A troublesome cough occasioned extreme pain in the wound, and in the course of the eighth day he died.

Upon dissection it was found that the external iliac artery was surrounded by a number of enlarged lymphatic glands. "The external surface of one of them next the wound had ulcerated; and the ulceration penetrated through the gland, and communicated with the artery, as was afterwards made evident by slitting open that vessel. It was through this aperture that the blood had escaped; for the ligature still remained firm upon that part of the artery which it had enclosed. The parts of the artery from which the former ligatures had separated, were about half an inch asunder, and the canal of the vessel appeared perfectly open. A coagulum of blood, about two inches long, was found above the part where the last ligature was made." It is probable that this coagulum was formed during the interval between the last hæmorrhage and the death of the patient*.

In the second case in which Mr. Abernethy tied the external iliac artery, the aneurism was very large, and situated close to Poupart's ligament. The operation was performed by making an incision, three inches in length, "through the

* *Surgical Observations, on Aneurisms*, p. 234. Second edit.

integuments of the abdomen, beginning a little above Poupart's ligament, and being continued upwards; it was more than half an inch on the outside of the upper part of the abdominal ring, to avoid the epigastric artery. The aponeurosis of the external oblique muscle being thus exposed, was next divided in the direction of the external wound. The lower part of the internal oblique muscle was thus uncovered, and the finger being introduced below the inferior margin of it and the transversalis muscle, they were divided by the crooked bistoury for about one inch and a half. I now introduced my finger," Mr. Abernethy observes, " beneath the bag of the peritoneum, and carried it upwards by the side of the psoas muscle, so as to touch the artery about an inch above Poupart's ligament. I took care to disturb the peritoneum as little as possible, detaching it to no greater extent than would serve to admit my two fingers to touch the vessel. The pulsations of the artery made it clearly distinguishable from the contiguous parts, but I could not get my finger round it with the facility which I expected. This was the only circumstance which caused any delay in the performance of the operation. After ineffectual trials to pass my finger beneath the artery, I was obliged to make a slight incision on either side of it, in the same manner as is necessary when it is taken up in the thigh, where the fascia

which binds it down in its situation is strong. After this I found no difficulty in passing my forefinger beneath the artery, which I drew gently down, so as to see it behind the bag of the peritoneum. By means of an eyed probe, two ligatures were conveyed round the vessel; one of these was carried upwards as far as the artery had been detached, and the other downwards: they were firmly tied, and the vessel was divided in the space between them. Nothing further remained than to close the external wound, which was done by one suture and some strips of sticking plaster. The threads of the upper ligature were left out of the wound above the suture which closed its edges, and those of the lower beneath."

The patient went on favourably, both with respect to his general health and the state of the limb, until the eighth day after the operation, when a high degree of constitutional irritation came on. For several days the discharge from the wound had been tinged with blood, and now, upon pressing the tumour beneath Poupart's ligament, a great quantity of blood, rendered fluid and highly fœtid by putrefaction, was forced out. The cyst was washed out with warm water, and an opening was made into it to afford the discharge a more ready exit. No abatement in the quantity or alteration in the quality of the discharge was however remarked. It seemed to be such as a

sloughing sore commonly furnishes. During a week the powers of the constitution appeared to rally, but after that time the patient's strength gradually declined, and he died on the twenty-third day after the operation. A few days before his death both ligatures came away with the dressings.

It was found by dissection that the peritoneum was separated from the loins and from the posterior half of the left side of the diaphragm by a considerable collection of blood, which extended downwards to Poupart's ligament, and communicated under that ligament by a small aperture with the aneurismal sac. The constitutional irritation and the death of the patient are to be ascribed to the condition of the sac, which, together with the contiguous parts, had sloughed in consequence of the irritation of the putrid blood. The sides of each extremity of the artery to which the ligatures had been applied were closed, and a small plug of coagulated blood was found in each *.

The subject of the third case in which Mr. Abernethy tied the external iliac artery was an irritable woman, who had been in the habit of drinking to excess. The aneurism was very large, and reached as high as Poupart's ligament. The operation was performed precisely in the same

* *Surgical Observations, on Aneurisms*, p. 250. Second edit.

manner as in the last case, on the 11th of October, 1806. Two ligatures were applied to the artery, which was divided in the interspace. The foot of the diseased limb continued colder than the other until the third day after the operation, when both limbs were of the same temperature. The patient was restless and irritable, her stomach was disordered, and the wound had an unhealthy appearance during the first fortnight. Her health after that time improved: the wound granulated, and was nearly healed in a month after the operation. The lower ligature was detached on the fifth day, and the upper came away on the fourteenth. At the end of a month the aneurismal tumour was more than one-third less than at the time of the operation. This patient completely recovered, and there remained no distinguishable difference in the size or strength of the two extremities*.

The fourth case in which Mr. Abernethy tied the external iliac artery also terminated successfully. The patient, a Swedish sailor, about forty years of age, was admitted into St. Bartholomew's Hospital, on account of an aneurism of the femoral artery just below the groin. The operation was accomplished as in the preceding cases, on the 25th of February, 1809. When the finger was

* *Surgical Observations, on Aneurisms*, p. 269. Second edit.

placed behind the peritoneum, the cylindrical form and firmness of the artery were clearly distinguished, but its pulsation could not be perceived. By compressing the vessel, the beating of the aneurism ceased: when the pressure was remitted, it returned. The artery was tied with two ligatures, but it was not divided between them. During the cure the patient had several attacks of pain in the epigastric region, attended with great disorder in the digestive organs. An abscess also formed near the knee. The ligatures came away on the tenth day, and the wound healed. When discharged from the hospital he was capable of walking with but little infirmity*.

Although the ligature of the external iliac artery had not, at that time, been succeeded by the recovery of the patients upon whom it was performed, the facts established by Mr. Abernethy's two first cases induced Mr. Freer to undertake the operation in the Birmingham Hospital, on the 4th of October, 1806. The patient was a large robust man, twenty-seven years of age. At the time of the operation the œdema had swoln the thigh to twice its natural diameter, and above this general enlargement the tumour appeared equal in size to a large melon.

* *Surgical Observations, on Aneurisms*, p. 281. Second edit.

"I began the operation," says Mr. Freer, "by making an incision about one inch and a half above the spine of the ilium, and extending it downwards about three inches and a half below, forming in the whole an incision three inches and a half in length, and extending to the base of the tumour. By this incision the skin and cellular membrane were divided, and the tendon of the external oblique muscle was exposed. Through it an opening was made the length of the external wound; the incision was then carefully and gradually continued through the internal oblique muscle. Between the peritoneum and transversalis muscle the finger was then introduced, which served as a director to the crooked bistoury, with which the muscle was slit up. This part of the operation being done, carefully avoiding any unnecessary disturbance, I separated the peritoneum with my finger, till I could feel the artery beating; but in this patient the artery was so firmly bound down by its fascia, that I could not get my finger under it without using the knife to divide the fascia. The artery was tied with a single ligature, and the pulsation in the tumour immediately ceased."

The patient recovered without an unfavourable symptom. The ligature was detached on the sixteenth day. The œdema of the limb subsided, and in a fortnight after the separation of the liga-

ture the tumour was so far diminished as to be nearly level with his thigh. Before he left the hospital he was able to walk two or three miles, and had completely regained the use of the limb*.

Twelve months had not elapsed after the cure of Mr. Freer's patient, when the operation was successfully repeated by Mr. Tomlinson of Birmingham. The patient was a spare, but healthy man, about forty years of age. The tumour was nearly the size of a large full grown apple. A single ligature was employed, and the patient recovered without an unfavourable symptom. The ligature was detached on the twenty-sixth, and the patient declared cured on the thirty-first day after the operation. The tumour gradually disappeared †. I saw this patient a year after the operation. He was in perfect health, and not a vestige of the aneurism could be discovered.

Since the occurrence of those instances which I have mentioned, Mr. Astley Cooper has tied the external iliac artery in six cases of inguinal and femoral aneurisms. Four of these patients completely recovered: one of them died thirteen weeks after the operation, in consequence of the rupture of an aneurism of the aorta: in another the leg mortified, and amputation was performed.

In addition to these cases, the external iliac

* *Observations on Aneurism*, p. 79. † Ibid. p. 91.

artery has been tied by several surgeons in England, Ireland, America, and France. I am acquainted with twenty-two instances in which this operation has been performed. In fifteen of these cases the patients completely recovered: in two the limb mortified: in a third a fatal hæmorrhage was the consequence of the extension of ulceration to the coats of the artery, from an adjoining lymphatic gland: in a fourth the aneurism burst into the cellular membrane behind the peritoneum, the sac sloughed, and the patient was exhausted by the consequent derangement of his general health: in a fifth gangrene attacked the sac, and extended to the thigh: in a sixth death was the consequence of the rupture of an aneurism of the aorta thirteen weeks after the operation: and in the seventh case the operation was not performed until the sac had burst, and the patient was so much reduced that he died on the third day*. Upon the whole, the

* The following is a brief account of these cases.

The external iliac artery has been tied by

———Mr. Abernethy, in four cases of inguinal aneurism. Two of these patients completely recovered. The causes of the fatal termination of the other two cases I have related above.

———Mr. Freer, in the Birmingham Hospital, with perfect success.

———Mr. Tomlinson, of Birmingham. The patient was cured.

———Mr. Astley Cooper, in six cases of inguinal and femo-

number of cases in which this operation has succeeded so much exceeds the number of those in which it has terminated unfavourably, that it may be regarded as decidedly established that the external iliac may be tied with as much safety as any artery to which a ligature has been applied for the cure of aneurism.

It is not only in cases of aneurisms arising from the femoral artery above the profunda that the

ral aneurisms. Four of these patients completely recovered: one of them was able to leave his house and attend to his business in a month after the operation. The fifth patient died thirteen weeks after the operation, in consequence of the rupture of an aneurism of the aorta; in the sixth the leg mortified, and amputation was performed.

————M. Delaporte, in the Naval Hospital at Brest. The patient was sixty years of age. The aneurism in the groin had acquired an immense bulk on the 3d of January, 1810, when the operation was performed precisely in the manner recommended by Mr. Abernethy. The artery was tied with two ligatures, but was not divided in the interspace. The patient went on favourably, both with regard to the limb and his general health, until the twelfth day, when the tumour increased in size, became soft, and of a purple colour. On the thirteenth day the thigh was cold and discoloured: vesications appeared on the tumour, and the pulse was feeble. On the fourteenth day mortification extended to the knee, and the patient died. It was found by dissection that the canal of the artery was not obliterated above or below the ligatures, although they were tied so tight that the injection could not pass through that portion of the vessel. The profunda originated from

ligature of the external iliac artery may be required; for when the disease arises below the origin of the profunda, and the tumour is large and extends upwards, so as to render it impossible to tie the femoral artery, it is sometimes necessary to perform this operation. The dissections recorded by Mr. Astley Cooper prove that the liga-

the lower extremity of the sac. The injection passed through the profunda, and was found in the femoral artery. This case is published in the *Mém. de la Société Médicale d'Emulation de Paris*, tom. vii.

———Mr. Goodlad, of Bury, in Lancashire, on the 29th of July, 1811. The artery was tied with two ligatures, but was not divided between them. The patient had scarcely an unfavourable symptom after the operation. The ligatures came away on the fourteenth day. At the end of a month the aneurism had decreased at least one-third, and the wound was perfectly healed. In less than two months the patient walked nearly two miles in one day: the lower extremities were of equal strength and thickness.—See *Edinburgh Medical and Surgical Journal*, vol. viii. p. 32.

———Mr. Ramsden, in St. Bartholomew's Hospital, in the year 1812. The patient was seventy-five years of age. The disease was of long duration. A slough formed on the tumour, which burst, and a profuse hæmorrhage ensued immediately before the operation. The patient was excessively feeble, and died on the third day after the operation, in consequence of extreme debility.

———Mr. Albert, in the York Hospital, Chelsea, in the year 1812. The tumour was large, and the limb prodigiously swoln before the operation. The artery was tied

ture of the external iliac artery will cure aneurisms arising from the femoral artery below the origin of the profunda. I have seen two cases, in which both from the situation of the tumours, and from the account which the patients gave of their com-

with a single ligature. The limb mortified, and the patient died with symptoms of tetanus in less than three weeks after the operation. The ligature had separated.

———Mr. Brodie, in St. George's Hospital, in the year 1813. The artery was tied with a single ligature. The patient recovered, and Mr. Brodie informs me that he is now in perfect health.

———Mr. Norman, in the Casualty Hospital at Bath, in October, 1813. A single ligature was applied: it was detached on the nineteenth day. The man recovered, and regained the perfect use of the limb.

———Mr. Lawrence, of St. Bartholomew's Hospital, on the 8th of January, 1814. The artery was tied with a single ligature, which came away on the 27th day. The sac (on which an eschar of the size of half-a-crown had formed) was opened on the 12th of February: this opening was closed on the 12th of March, and in less than three months after the operation the man was discharged from the hospital, a small fistulous aperture still remaining at the wound.

———M. Bouchet, principal surgeon to the Hôtel Dieu at Lyons. This case is mentioned by M. Roux, *Nouveaux Elémens de Médecine Operatoire*, tom. i. p. 744. M. Roux informs me that the patient was cured.

In addition to these instances, I am informed, upon good authority, the external iliac artery has recently been tied with success at Dublin and Philadelphia.

mencement, there can be little doubt that the disease arose either from the commencement of the profunda, or from the femoral artery below the origin of that branch. In both instances the external iliac artery was tied, and the patients were cured.

There are two modes of tying the external iliac artery: the first which I shall describe is employed by Mr. Abernethy: the second is adopted by Mr. Astley Cooper. The following is Mr. Abernethy's method of performing this operation:

The patient being placed upon a table, in a horizontal position, an incision four inches in length is to be made through the integuments of the abdomen, in the direction of the external iliac artery. This incision will be situated about an inch and a half from the anterior superior spine of the ilium, towards the linea alba: the lower extremity will terminate about half an inch above Poupart's ligament. The sides of this incision through the integuments being separated, the aponeurosis of the external oblique muscle will be exposed, and is to be divided throughout the extent of the external wound. The finger is then to be introduced underneath the inferior margins of the internal oblique and transverse muscles, so as to protect the peritoneum whilst the operator divides these muscles with a common knife or a probe-pointed bistoury. The finger is then to be passed

behind the peritoneum, until it arrives at the inner edge of the psoas muscle, where the pulsation of the artery will be distinctly felt. The external iliac vein is situated on the inside of the artery: the psoas muscle lies between the artery and the anterior crural nerve. The artery and vein are connected together by dense cellular membrane, which is to be separated with the nail, or divided with a knife, so as to enable the operator to introduce the point of the aneurism-needle between the artery and vein, and bring it out on the opposite side of the former. The ligature which is thus conveyed round the artery being secured, the wound is to be closed with strips of adhesive plaster. When the patient is placed in bed, the thigh should be bent upon the pelvis, so as to place the artery in a relaxed condition.

Mr. Astley Cooper's mode of performing this operation consists in making a semilunar incision through the integuments in the direction of the fibres of the aponeurosis of the external oblique muscle. One extremity of this incision will be situated near the spine of the ilium: the other will terminate a little above the inner margin of the abdominal ring. The aponeurosis of the external oblique muscle will be exposed, and is to be divided throughout the extent and in the direction of the external wound. The flap which is thus formed being raised, the spermatic cord will be seen passing under the margin

of the internal oblique, and transverse muscles. The opening in the fascia which lines the transverse muscle, through which the spermatic cord passes, is situated in the mid space between the anterior superior spine of the ilium, and the symphysis pubis. The epigastric artery runs precisely along the inner margin of this opening, beneath which the external iliac artery is situated. If the finger therefore be passed under the spermatic cord through this opening in the fascia which lines the transverse muscle, it will come into immediate contact with the artery, which lies on the outside of the external iliac vein. The artery and vein are connected together by dense cellular membrane, which must be separated to enable the operator to pass a ligature, by means of an aneurism-needle, round the former.

In this manner the operation is accomplished with very little disturbance to the peritoneum, and the ligature is applied to the most superficial part of the external iliac artery. Mr. Astley Cooper has employed this mode of operating in six cases: through his kindness I had an opportunity of seeing some of these operations, and remarked the facility with which the artery was exposed and tied in the manner which I have now described. When, however, the tumour is large, and extends over Poupart's ligament, it will be impossible to adopt this mode of operating. There

is also some danger of tying the artery immediately below the origin of the epigastric or circumflex iliac arteries, more especially if either of these vessels arise rather higher than usual; and this circumstance may prove a cause of secondary hæmorrhage*. When this mode of operating is employed, it is advisable therefore that the ligature be applied as high up as the space will allow, or even that the muscles and fascia be divided to a small extent, to enable the operator with certainty to tie the artery at some distance from the origin of these vessels.

This occurred to me in his case

* See page 210.

SECTION IX.

ON GLUTEAL AND ISCHIADIC ANEURISMS.

ANEURISMS of the gluteal artery have generally been regarded as incurable; and the only instance hitherto recorded in which the cure of this disease was effected by a surgical operation is related by Mr. John Bell. Mr. Bell opened an immense aneurism arising from a wound of the "posterior iliac artery," and tied the divided vessel. The sac suppurated, and the sacrum and ilium exfoliated, but the patient ultimately recovered *.

The danger which attends the exposure of the cavity of an aneurism in a situation in which it is impossible to command the flow of blood by the compression of the artery above the tumour, has deterred surgeons from repeating Mr. Bell's operation. Dr. Stevens, of the island of Santa Cruz, has communicated to the Medical and Chirurgical Society the history of a case in which he cured a gluteal aneurism by tying the internal iliac artery †. I am indebted to Dr. Stevens for the following abstract of this important case:—

"Maila, a negro woman, was imported as a

* *Principles of Surgery*, vol. i. p. 421.

† See *Medico-Chirurgical Transactions*, vol. v.

slave into the West Indies in the year 1790. I saw her first in the beginning of December, 1812. At that time a tumour, which pulsated strongly, was situated on her left hip, immediately over the sciatic notch. It was nearly as large as a child's head. She could assign no cause for the disease, which commenced about nine months before I saw the patient with slight pain, and had gradually increased to its present size. She was now much reduced, in great pain, and willing to submit to any operation.

" I consulted Dr. Lang and Dr. Van Brackle about this case, and proposed to them the operation of tying the internal iliac artery, to which they consented; and on the 27th of December, 1812, I performed the operation in the following manner, in the presence of Dr. Lang, Dr. Van Brackle, Mr. Nelthropp, and Mr. Ford, the manager of the estate to which the woman belonged.

" An incision about five inches in length was made on the left side in the lower and lateral part of the abdomen, parallel with the course of the epigastric artery, and nearly half an inch on the outside of that vessel. The skin, the superficial fascia, and the three thin abdominal muscles, were successively divided. The peritoneum was separated from its loose connexion with the iliacus internus and psoas magnus muscles: it was then

turned inwards in a direction from the anterior superior spinous process of the ilium to the division of the common iliac artery. In the cavity which I had now made I felt for the internal iliac artery, and having insinuated the point of my finger behind it, I compressed the artery between my finger and thumb. At the same time Dr. Lang felt the aneurism, and observed that the pulsation had ceased, and that the tumour was decreasing. I examined the vessel in the pelvis with my finger: I found that it was healthy, and that I had accurately detached it from the neighbouring parts. I then passed a ligature underneath the artery with a small blunt needle, and tied it with a single ligature, about half an inch from its origin.

"The tumour disappeared almost immediately after the operation, and the wound healed favourably. About the end of the third week the ligature came away, and in six weeks the woman was perfectly well. When I was about to leave the West Indies in the early part of May, 1814, more than seventeen months after the operation, I called upon this woman, and found her in perfect health."

I have several times repeated this operation upon the dead subject, and have found no difficulty in tying the internal iliac artery in the manner which Dr. Stevens describes. The centre of the

incision through the integuments and abdominal muscles should be situated nearly opposite to the anterior superior spinous process of the ilium: the peritoneum may then be separated from the iliac and psoas muscles, and the external iliac artery traced to its origin from the common iliac. At this point the internal iliac will be found, and a ligature may be passed underneath it by means of a common aneurism-needle.

The numerous communications between the branches of the internal iliac and the lumbar and femoral arteries will furnish a sufficient quantity of blood, when the internal iliac artery is obliterated, for the nourishment of those parts which in their natural state are supplied in a direct course by this vessel.

SECTION X.

ON FEMORAL, POPLITEAL, AND TIBIAL ANEURISMS.

In a former Section I have described the channels through which the blood is conveyed into the limb when the femoral artery is obliterated above the origin of the profunda: I have now to consider the mode in which this object is effected when the obliteration of the femoral artery is situated below the origin of the profunda.

It was formerly conceived that the femoral artery sometimes divided near the groin into two trunks, which supplied the leg in the same manner as the brachial artery occasionally divides into the radial and ulnar near the axilla; and that this peculiar conformation existed in those instances in which the circulation of the limb was carried on after the obliteration of the femoral artery. This appears to have been the opinion of Heister * and Gooch †, although anatomists had previously described the origin of the profunda, and demonstrated its anastomoses with the branches of the popliteal artery. It is now generally known that the anastomoses between

* See HALLER, *Disputationes Chirurgicæ*, tom. v. p. 141, 149.

† *Philosoph. Transactions*, vol. lxv. p. 378.

the descending or perforating branches of the profunda, and the articular arteries of the knee, are the channels through which the circulation of the limb is carried on when the femoral artery is obliterated immediately below the origin of the profunda. These communications are so large and numerous, that they may be demonstrated by the injection and dissection of a healthy limb.

When the femoral artery is obliterated where it perforates the tendon of the adductor muscle, not only do the communications between the branches of the profunda and the articular arteries of the knee afford a passage for the blood into the inferior trunks of the limb, but the muscular branches which arise from the femoral artery between the part which is obliterated and the origin of the profunda contribute, by their anastomoses with the articular arteries, to carry on the circulation of the limb. When the femoral artery is tied near the tendon of the adductor muscle, the obliteration sometimes extends from the part at which the ligature is applied to the origin of the profunda*: but this is not always the case; for in some instances the circulation continues through muscular branches arising from the femoral artery below the

* This was the case in the first instance in which Mr. Hunter performed the modern operation.—See *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 153.

origin of the profunda, and consequently the main artery and its branches remain pervious to the part obliterated by the direct operation of the ligature. In a case in which Deschamps performed the modern operation for popliteal aneurism, the femoral artery in the middle of the thigh, where the ligature had been applied, was obliterated for the space of two inches and a half: immediately above this portion of the femoral artery an anastomosing branch arose, which prevented the obliteration from extending to the origin of the profunda*. I am informed that Mr. George Bell of Edinburgh possesses a preparation of a limb in which the femoral artery had been tied for a popliteal aneurism, and that the obliteration of the artery did not extend to the origin of the profunda.

When a portion of the popliteal artery is obliterated, as in the old operation for popliteal aneurism, the circulation is carried on through the anastomoses of the superior articular, with the inferior articular and recurrent tibial arteries. Pelletan injected and dissected a limb twelve months after the ligature of the popliteal artery. The trunk was obliterated from the superior articular to the commencement of the tibial arteries. The superior

* *Mémoires presentées à l'Institut des Sciences*, &c. tom. i. p. 251. An. 1805.—See SCARPA, *Treatise on Aneurism*, WISHART's *Translation*, p. 465.

articular were remarkably dilated, and communicated by several large anastomoses with recurrent branches of the tibial arteries *.

When the obliteration of the popliteal artery includes the origins of the superior articular arteries, the latter will constitute an intermediate series of anastomosing vessels, through which the blood will be transmitted from the branches of the profunda, and the muscular branches of the femoral artery into the inferior articular and the recurrent branches of the tibial arteries. Desault dissected a limb in which an aneurism of the superior part of the popliteal artery had undergone a spontaneous cure, by which the orifices of the superior articular arteries were obliterated. The injection had passed through anastomosing branches into the superior articular, from which it was transmitted into the inferior articular and recurrent tibial, and through these into the popliteal and tibial arteries below the obliterated portion of the trunk †.

When the whole extent of the popliteal artery is obliterated, so as to include the mouths of both the superior and inferior articular arteries, a still more extensive circle of anastomosing vessels will be engaged in conveying blood into the leg. Under these

* *Clinique Chirurgicale*, tom. i. p. 127.

† *Journal de Médecine de Paris*, tom. lxxi. p. 430.

circumstances the blood which enters the superior will pass into the inferior articular arteries; but instead of being discharged through the latter into the popliteal, it will pass into recurrent branches of the tibial arteries, and will thus be conveyed through several series of anastomosing vessels before it arrives at the trunks of the leg. Mr. Astley Cooper injected and dissected a limb seven years after the femoral artery had been tied for the cure of a popliteal aneurism. The femoral artery was converted into a solid cord, from the origin of the profunda to the commencement of the tibial arteries. The muscles of the thigh, which usually receive blood from the femoral artery, as the sartorius, the rectus, and the vasti, were supplied by the branches of the profunda; and the articular arteries, although they were still capable of receiving blood, derived it not from the popliteal artery, but from their communications with the branches of the profunda. The anastomoses between the superior and inferior articular arteries formed a plexus of vessels in the ham, which received blood from the branches of the profunda, and conveyed it into recurrent branches of the tibial, and the arteries which supply the gastrocnemius muscle *.

The operation for femoral and popliteal aneu-

* *Medico-Chirurgical Transactions*, vol. ii. p. 254. plate VII.

risms consisted in opening the sac, and tying both extremities of the artery in that situation, until the year 1785, when Mr. Hunter proved the possibility of curing these diseases by tying the artery at a distance from the tumour. In a former part of this Treatise I have related the history, and pointed out the advantages of this great improvement in the surgical treatment of aneurism*. I have also mentioned a peculiarity in the collateral circulation which sometimes exists after a popliteal aneurism is cured by the ligature of the femoral artery at a distance from the tumour†. At present, therefore, I have only to consider the different modes in which the operation of tying the femoral artery has been performed.

Mr. Hunter performed the operation of tying the femoral artery for the cure of popliteal aneurism, by making an incision on the anterior and inner part of the thigh, rather below its middle. This incision was continued obliquely across the inner edge of the sartorius muscle, which was drawn aside, and the femoral artery was tied near the part which passes through the tendon of the adductor muscle‡. In this situation the artery lies at a distance from the surface of the limb, and

* See page 185—190. † See page 277.

‡ *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 148.

its exposure, so as to enable the operator to pass a ligature under it, is effected with difficulty. The displacement of the sartorius and the depth of the wound are also very liable to give rise to the formation of sinuses. Since the time of Mr. Hunter, most operators have therefore preferred tying the artery in the upper part of the thigh, a little below the origin of the profunda, where the situation of the vessel is more superficial, and its coats are less liable to be affected with those morbid alterations which almost constantly exist in the vicinity of aneurisms. When an artery is tied close to an aneurism, the inflammation excited by the operation sometimes extends to the sac, and gives rise to the most serious consequences. This circumstance constitutes an additional argument for performing the operation at a distance from the disease, and the principal channels through which the circulation is carried on, are the same when any portion of the femoral artery is tied below the origin of the profunda.

The part of the limb in which the femoral artery can be tied with the greatest facility is between four and five inches below Poupart's ligament. The profunda generally arises from the femoral artery an inch and a half or an inch and three quarters below Poupart's ligament. It very rarely arises so low as two inches. If, therefore, the ligature be applied to the femoral artery at

the distance of four or five inches below Poupart's ligament, the surgeon will not be embarrassed by meeting with the profunda during the operation, and the chance of causing secondary hæmorrhage by tying the artery close to the origin of this vessel, will be obviated.

Some operators prefer making the incision on the outer edge of the sartorius, and exposing the artery by elevating that muscle, and drawing it inwards. Others make the incision on the inside of the sartorius, and tie the artery at the part where the muscle crosses it. The former allege, in support of their mode of operating, the chance of wounding the saphena vein or the trunks of the lymphatics which lie in that situation, by making the incision on the inside of the sartorius *. The chance of wounding the saphena vein may be avoided by making the incision precisely upon the sartorius, so as to expose its fibres at the inner margin of the muscle. By drawing the edge of the muscle a little outwards, the course of the artery will be exposed. I am informed by some of the most experienced operators in this country, that they have never witnessed any unpleasant consequences after this operation which they could

* See *A Letter addressed to the Commissioners for Transports, on the Operation for Popliteal Aneurism*, by A. C. Hutchison, M. D.

impute to the division of lymphatics; and in several cases which I have had an opportunity of seeing, no inconvenience arose from this circumstance. It appears to me that the operation is accomplished with less disturbance to the parts covering the artery when the incision is made upon the inner margin of the sartorius, and consequently the formation of sinuses is less likely to take place than when the artery is exposed by raising that muscle.

The following is the mode in which this operation may be performed:

The patient being placed in a horizontal position, the operator observes the course of the sartorius muscle, which will be rendered more apparent by turning the knee a little inwards. He then makes an incision through the integuments upon the inner edge, and in the course of the sartorius, commencing it two inches and a half below Poupart's ligament. This incision is to be three or four inches in length, and continued down to the fibres which form the inner margin of the sartorius. The edge of this muscle is then to be drawn a little outwards, and the operator will trace with his finger, introduced into the bottom of the wound, the pulsation of the artery lying underneath the fascia lata. At the part where the artery passes under the sartorius, the fascia lata is to be divided to the extent of about an inch.

The artery lies under the fascia lata, surrounded by its proper cellular sheath: the femoral vein is situated immediately under the artery: the branches of the anterior crural nerve lie on the outside of the artery, nearer to the thigh bone, and are separated from the artery by firm cellular membrane: sometimes a small nerve passes immediately over the artery under its fascia. The coats of the artery being fairly exposed, the ligature is to be passed round it with a common aneurism-needle, the point of which is to be kept in close contact with the artery, so as to avoid including the femoral vein, or the branches of the anterior crural nerve. The ligature being secured, the wound is to be closed solely with strips of adhesive plaster.

When an aneurism arises from either of the tibial arteries, near the commencement of those vessels, it may be cured by tying the femoral artery in the upper part of the thigh. I have seen three cases in which aneurisms situated underneath the upper part of the calf of the leg, were cured by the ligature of the femoral artery in the manner which I have described. From the situation of the tumours, there can be little doubt that they arose from the commencement of one of the tibial arteries.

But when an aneurism is situated in the lower

part of the leg, it will be necessary to tie the artery from which it arises near to the tumour. The recurrent circulation through the large inosculations in the foot will in some instances be sufficiently powerful to cause the increase of an aneurism arising from either of the tibial arteries after the application of a ligature at a distance from the tumour; for the blood which enters the sac from the inferior extremity of the vessel will pass through it into branches which arise from the artery between the aneurism and the seat of the ligature. On this account it is desirable that the artery should be tied as near as possible to an aneurism which arises from either of the tibial arteries below the middle of the leg. A case has been related to me in which the anterior tibial artery was tied in the middle of the leg for an aneurism situated upon the ankle. The pulsation continued, and the tumour increased in size after the operation.

The posterior tibial artery may be tied in the middle of the leg by making an incision, three or four inches in length, through the integuments on the inner edge of the tibia. The origin of the soleus muscle must be detached from the tibia throughout the whole extent of the external wound. The fascia which extends from the tibia to the fibula, and covers the deep-seated muscles of the

leg, will thus be exposed. The artery lies under this fascia upon the tibialis posticus and flexor digitorum pedis muscles. The tibial nerve is situated on the fibular side of the artery, which lies between two veins. Upon the dead subject this operation is accomplished with facility, but during life it will be rendered difficult by the resistance of the muscles, and will require an extensive division of the soleus muscle, and of the fascia covering the artery.

Behind the ankle the situation of the posterior tibial artery is very superficial. It lies nearer the heel than the tendons of the tibialis posticus and the flexor digitorum pedis. It retains the same relative situation with regard to its veins and the tibial nerve as in the middle of the leg.

The anterior tibial artery may be tied in the upper part and in the middle of the leg by making an extensive incision through the integuments upon the fibular margin of the tibialis anticus muscle. The strong fascia passing from the tibia to the fibula is then to be divided throughout the extent of the external wound. The tibialis anticus is to be separated from the extensor digitorum pedis. The artery is situated under these muscles upon the interosseous ligament. It is accompanied with two veins and a nerve: the nerve generally lies upon the artery.

A few inches above the ankle the situation of the anterior tibial artery is more superficial. It lies under the integuments and fascia between the tendons of the extensor pollicis and the extensor digitorum pedis.

SECTION XI.

OF ANEURISM FROM ANASTOMOSIS, AND ANOMALOUS TUMOURS ARISING FROM DISEASED ARTERIES.

THAT peculiar disease to which the term aneurism from anastomosis has been applied by Mr. John Bell*, may with propriety be classed among the diseases of arteries. It consists of a congeries of cells, into which arteries pour their blood, and veins or other arteries receive it, so that in its structure it resembles the fabric of the penis, the placenta, or the spleen. It is generally attended with pulsation, or a thrilling sensation like that which is observed in aneurismal varix. In some instances this disease is the consequence of accidental violence: sometimes it grows from those red marks or defects in the structure of the skin which exist from the time of birth. In its early stage the tumour is a mere pimple, and appears to consist of a congeries of arteries and veins. In this state it is firm, and the throbbing indistinct: but as the cellular structure which ultimately forms the bulk of the swelling is developed, it

* *Principles of Surgery*, vol. i. p. 456, and vol. iii. p. 255.

becomes more compressible, and the pulsation more evident. At last it appears to consist of a cluster of sacs of a purple or livid colour, which burst from time to time, and bleed profusely. The pulsation in the tumour is increased by all causes which accelerate the action of the heart and arteries. It diminishes during sleep, and is increased by passion or bodily exertion. It increases during menstruation, and in some instances a periodical bleeding from the tumour has supplied the place of that discharge*.

Mr. John Bell describes this tumour as consisting of " a congeries of small and active arteries, absorbing veins, and intermediate cells. The irritated and incessant action of the arteries fills the cells with blood, from these cells it is reabsorbed by the veins, the extremities of the veins themselves perhaps dilate into this cellular form†." This structure resembles that imaginary parenchyma, or cellular substance, which the early anatomists imagined to be interposed between the extremities of the arteries and the veins in all parts of the body. In some cases the neighbouring veins are remarkably dilated, and constitute the bulk of the tumour. Pelletan found not only the veins, but also the trunks, as well as the

* DESAULT, *Journal de Chirurgie*, tom. ii. p. 71.

† *Principles of Surgery*, vol. i. p. 457.

branches of the arteries which supplied the disease, unusually large and dilated*.

We are indebted to Mr. John Bell for the most accurate account of this disease. Cases of it have been recorded by different writers, under various denominations. In most of the instances upon record, the disease was situated in the integuments of the head, and generally arose from some congenital mark or defect in the skin.

The early extirpation of these tumours, when they are situated in parts in which the operation is practicable, should in all instances be undertaken. It is advisable that the incisions for its removal be made at a distance from the disease, that the vessels by which it is supplied may be divided before they are much ramified. Near to the tumour the arteries are very large and numerous; but by making the incision at a distance from it, the trunks are divided instead of these dilated branches, and the hæmorrhage is more easily controlled. The partial removal of the tumour by ligature†, or by the application of caustic, has been followed by an increase of its growth.

The diminution of the force of the circulation in the tumour will not only prevent the increase, but even effect the cure of this disease. A knowledge

* *Clinique Chirurgicale*, tom. ii. p. 59, 66—68.

† See PELLETAN, *Clinique Chirurgicale*, tom. ii. p. 70.

of this fact is of great importance, because it points out a mode of controlling this disease, when from its extent or situation the tumour cannot be extirpated. Mr. Travers tied the carotid artery in a woman whose eye was thrust outwards by a pulsating tumour which filled the greater part of the orbit. "The upper half of the inner canthus was filled by the thrilling tumour, which presented a loose woolly feel, was very compressible, and when firmly compressed, offered a slight pulsation. The veins of the superior eyelid were varicose from distention; the skin was much pursed over the lachrymal sac, and the veins on the sides of the nose turgid. The lower tumour, which projected above the suborbitar hole, was of a conical shape, and firmly elastic to the touch. The under lid was raised as far as to the outer angle of the orbit, above the apex of the cheek. This lower tumour could be emptied or pressed back into the orbit, but the pulsation then became violent; and from the increased pressure of the globe upon the roof and side of the orbit, the pain was insupportable. Careful compression of the temporal, angular, and maxillary arteries, produced no effect on the aneurism." When the common carotid artery was compressed, the pulsation ceased altogether, and the whiz of the little swelling was rendered so exceedingly faint, that it was difficult to determine whether it continued or not. Compression of the

tumour produced insupportable pain, and cold applications had been tried without advantage. Being satisfied of the growth of the disease; knowing under favourable circumstances the moderate risk of placing a ligature on the carotid artery; and particularly reflecting that the obstruction of such a channel must, at all events, be followed by a sensible and permanent diminution of the impulse of the blood destined to the disease, Mr. Travers tied the carotid artery. The circumstances which relate to the operation I have already detailed *. Before the patient was removed from the table, she observed that the pain was numbed, and that the noise in her head had entirely ceased. The small tumour over the angle of the eye was still thrilling, but very obscurely. On the third day after the operation a thrilling sensation was observed in both tumours upon light contact of the finger: if firmly compressed, a pulse could be perceived in the lower. On the fifth day the tumours were very considerably diminished, and the eye less prominent. The globe of the eye communicated a slight pulsation. At the end of the fifth week the tumours were obviously diminished: the pulsation had decreased, and the patient was free from the severe pains which had distracted her for years before the operation. Four months after the ope-

* See page 326.

ration the tumours were evidently smaller, and their motion materially diminished. About five months after the operation she miscarried, at the period of ten weeks from conception. The hæmorrhage was so considerable as to induce syncope, and leave her in a state of extreme debility. On the succeeding morning it was observed that the upper tumour was flattened, and the pulsation had altogether ceased. In the course of the month after this occurrence, the upper tumour and the gathers of integument between the eyebrows had totally disappeared. The eye projected less; the lower tumour was inelastic, and void of pulsation. She continued for some time in a state of great debility and lowness, which was increased by discharges of blood from the bowels. Two years after the operation the only vestige of the disease that remained was a knob of the size of a large pea over the inner angle of the eye*. I have lately had an opportunity of examining this patient, nearly five years having elapsed since the carotid artery was tied. She is in perfect health, and has been thrice pregnant since the operation. The cure of the aneurism is so complete, that it is impossible to discover that disease has existed in the orbit.

In a similar case it would probably be advisable to aid the process of cure after the operation by

* *Medico-Chirurgical Transactions*, vol. ii. p. 1.

depletion and abstinence. In Mr. Travers's patient the diminution of the tumour was very remarkable after violent discharges of blood from the uterus and intestines.

There is a species of congenital deformity which very much resembles that disease which I have now described. It consists of a cluster of enlarged vessels, or of cells, which are distended by the influx of blood. It occurred to Mr. Abernethy that the distention and consequent enlargement of the dilated vessels depended upon an inflammatory action of the surrounding arteries; and that by subduing this inflammatory action the disease would subside, whilst the obliteration of the dilated vessels might be promoted by equal and permanent pressure. Mr. Abernethy has related some cases in which this treatment was adopted *. The part was compressed by adhesive straps or rollers, which were constantly moistened with an evaporating lotion. By continuing the use of these remedies for some months, the tumours entirely subsided, and the disease was permanently cured. In one instance related by Mr. Abernethy, in which the disease was situated in the orbit, the employment of pressure to any extent was evidently impracticable. The abstrac-

* *Surgical Observations, on Injuries of the Head, and on Miscellaneous Subjects*, p. 224.

tion of heat, by constantly using an evaporating wash, caused the tumour regularly to recede, and in a few months no appearance of it remained*. Pelletan relates a case in which he cured a similar tumour situated upon the forehead by constant pressure †. I have at this time a child under my care, in whom the disease is nearly cured by compression. The tumour is situated upon the scalp. When the child was born the swelling was very small, but soon after birth it increased rapidly. It was of a purple colour, and enlarged when the child cried. It could be emptied of its contents by pressure. It was not attended with pulsation, but the arteries and veins by which it was supplied were remarkably dilated. It is now seven weeks since I commenced the compression by means of a piece of card, which was firmly bound upon the tumour by adhesive straps. The tumour is at least two-thirds less since this treatment was employed. When the means which I have mentioned cannot be used on account of the situation of the disease, the early extirpation of these tumours is advisable.

Mr. Pott has described a peculiar tumour, which he had seen in the calf of the leg, and

* Ibid. p. 228. A similar case is related by BOYER, *Traité des Maladies Chirurgicales*, tom. ii. p. 269.

† *Clinique Chirurgicale*, tom. ii. p. 68.

the origin of which he imputed to a diseased condition and rupture of the posterior tibial artery. "It begins by a small, hard, deep-seated swelling, sometimes very painful, sometimes but little so, and only hindering the patient's exercises; it does not alter the natural colour of the skin, at least until it has attained a considerable size; it enlarges gradually, does not soften as it enlarges, but continues through the greatest part of it incompressibly hard; and when it is got to a large size, it seems to contain a fluid which may be felt towards the bottom, or resting, as it were, on the back part of the bones. This fluid is generally small in quantity, and consists of a sanies mixed with grumous blood *." In the following cases, which I had opportunities of examining, the principal arteries of the limbs were perfectly healthy: the disease appeared to arise not from a rupture of the trunks, but from some of the smaller arteries which opened into the tumour.

CASE XLI.

A LARGE tumour occupied the whole circumference of the lower part of the thigh of a man about fifty-five years of age. This swelling had

* POTT. *Chirurgical Works*, vol. iii. p. 223. Sir James Earle's edition.

existed nearly six months. It commenced a few inches above the inner condyle of the femur. At first it was moveable, but, as it increased, it gradually became more attached to the bone. Its growth was attended with violent pain. The skin was not discoloured, nor the veins enlarged. It was elastic, but not very compressible; no pulsation could be discovered in it. The knee possessed the power of motion, and the pulse at the ankle was natural. An incision was made into the tumour, to ascertain the nature of its contents. A quantity of fluid blood rushed out, and was followed by clots of coagulum. When the clots were sponged out, a copious hæmorrhage took place from the surface of the sac. The thigh bone was found to be denuded throughout its whole circumference, and so much diseased that the amputation of the limb was deemed necessary. The stump appeared to do well for some days, when its surface began to slough, and the patient died in a fortnight. The amputated limb was injected and dissected, but no large vessel could be discovered communicating with the sac. The popliteal artery pursued its usual course, passing over the posterior part of the sac. Extensive depositions of calcareous matter had taken place in all the arteries of the limb. The femoral vein was healthy. The sac appeared to be formed by the

surrounding muscles and fascia, and was divided by numerous septa, in some of which patches of bony matter had been deposited. It contained partly fluid and partly coagulated blood, which in some places had a membranous appearance. A quantity of injection was extravasated into the sac, but we could not discover any large vessel from which it had issued. The mouths of many minute arteries were seen upon its surface, through which the injection had been discharged into the sac.

CASE XLII.

A WOMAN, thirty years of age, had for several months suffered severe pain and fever, which attended the growth of a tumour at the lower part of the thigh. The swelling had the same appearance as that which I have described in the last case: it was situated in the same part of the limb, but was not so large. Its origin was imputed to violent extension of the muscles of the thigh. The limb was amputated; but the patient, who was extremely reduced by her previous sufferings, died in the course of a few weeks. The principal arteries and veins in the amputated limb were carefully dissected. They were in their natural state; not the slightest disease or rupture

could be discovered in them. The sac was of a thin membranous structure, and divided into numerous cells, which contained blood in different stages of coagulation. Calcareous matter was deposited in some parts of the sac. The thigh bone was carious.

CASE XLIII.

A THIN delicate boy, twelve years of age, was afflicted with a tumour on the outside of his right leg, which gradually increased until it was equal in size to the head of a new-born infant. The characters of the swelling coincided in every respect with Mr. Pott's description of this disease. It commenced immediately below the knee, and extended lower than the belly of the gastrocnemius muscle. The apex of the tumour was much inflamed, and the veins upon its sides were varicose. The sensation of the limb was natural: the pulse at the ankle was perfect. Sometimes the boy complained of pain in the tumour: at other times it was insensible. In the lower part fluctuation was imperfectly perceived: the upper part felt solid. An incision was made into the tumour, and a quantity of fluid blood, mixed with much coagulum, was immediately discharged. When the finger was introduced into the cavity, extensive depositions of bony matter, with the total destruc-

tion of the head of the fibula, were distinctly perceived. The limb was amputated. The sac was found to be of a dense structure, containing innumerable cells, which were composed principally of bony matter. These cavities contained fluid blood and coagulum of various degrees of density. In some places small masses of calcareous matter were found in the coagulum. The upper part of the fibula to the extent of three inches was destroyed. The muscles were very much attenuated, and were expanded over the tumour. When the contents of the tumour were removed, and water was injected into the femoral artery, it ran into the sac through a number of small vessels. The arteries of the limb were afterwards injected with wax, but in the dissection we could not discover any large vessel which communicated with the sac. The popliteal, the tibial, and fibular arteries, were healthy in their structure, and uninterrupted in their course *.

From these cases it is evident that the principal arteries are not always concerned in the production of this disease, as stated by Mr. Pott; and it is probable that the tumour arises from a rupture

* This case occurred in the practice of Mr. Freer of Birmingham. The above is an abstract of Mr. Freer's account of this case. — See *Observations on Aneurism*, p. 28. plate III.

of some of the smaller arteries *. Extirpation appears to be the only mode of treating this disease: and in the cases which I have seen, amputation of the limb has been necessary, in consequence of the effects of the disease upon the bones and surrounding parts.

* This circumstance has induced Mr. Freer to denominate this disease Aneurism of the extreme Arteries.—See *Observations on Aneurism*, p. 20. Cases of this disease are related by Else, *Medical Observations and Inquiries*, vol. iii. p. 169.—Pearson, *Medical Communications*, vol. ii. p. 95.—Scarpa, *Treatise on Aneurism*, Wishart's *Translation*, p. 439. In two of the cases related by Mr. Else, a probe introduced into the great veins of the limb passed readily into the tumours; but in two of the cases which I have related the principal veins were healthy, and no communication could be discovered between them and the tumours. In the cases recorded by Mr. Pearson and Scarpa, the tumours possessed so strong a pulsation that they were conceived to be aneurisms of the anterior tibial artery. In Mr. Pearson's case, however, it was found by dissection that the head of the tibia was so much destroyed that the posterior part of the tumour was in contact with the great arteries of the limb from which the pulsation was derived. In Scarpa's case, which was similar to Mr. Pearson's both as to the appearances of the tumour and its situation, "it was distinctly perceived that the lower portion of the body of the tibia was no longer in continuity with the upper."

PART III.

SECTION I.

ON WOUNDED ARTERIES.

THE process employed by Nature for the suppression of hæmorrhage, and the reparation of wounded arteries, is modified by the extent of the injury inflicted on the coats of the vessel. In punctured arteries the immediate suppression of the hæmorrhage is effected by the injection of blood between the artery and its sheath, so as to form a thick layer of coagulum, which, by extending over the orifice in the artery, affords a temporary barrier to the flow of blood. In a few hours the wounded edges of the artery inflame, and pour out coagulating lymph, whereby they are ultimately united in the same manner as wounds in soft parts in general are healed by the adhesive inflammation. When the wound is slight, the continuity of the canal is preserved, and after a certain time the cicatrization cannot be discovered

either on the external or internal surface of the vessel: but when the wound is extensive, though not beyond the possibility of being reunited, the effusion of lymph is sometimes so great, that the canal of the vessel is more or less obstructed by it*.

In extensive transverse wounds, or complete divisions of arteries, a different process takes place. The retraction of the vessel prevents the union of its divided edges, so as to restore the continuity of the tube. The hæmorrhage is suppressed by the obliteration of the canal of the artery, and the blood is conveyed to the parts which it is destined to supply through collateral channels.

Petit was the first who attempted to explain the means which Nature employs for the suppression of hæmorrhage. He conceived that the bleeding from a divided artery was stopped by the formation of a plug of coagulated blood, which was situated partly within and partly on the outside of the extremity of the vessel. This plug he supposed afterwards to become united to the internal surface of the vessel, to its divided edges, and to the surrounding parts†. Morand allowed that the coagulum had some effect in suppressing the hæmorrhage; but he contended that the corrugation or

* Jones *on Hæmorrhage*, chap. ii.

† *Mém. de l'Acad. Roy. des Sciences de l'année* 1735.

constriction of its circular fibres, by which the calibre is diminished, and the retraction and consequent thickening of its longitudinal fibres were the principal means by which the canal of the vessel was closed*. Sharp also asserted, that it was by contracting and withdrawing themselves into the wound that the extremities of divided blood vessels were shut up with coagulated blood†. Pouteau denied the efficacy of the plug of coagulum or the retraction of the vessel, and asserted that the tumefaction of the cellular membrane at the circumference of the divided extremity of the artery, formed the principal impediment to the flow of blood‡. Gooch‖, White§, Aikin¶, and Kirkland** contended, that it was owing to the constriction and retraction of the extremities of the divided vessel that the hæmorrhage was suppressed: and Mr. John Bell says, that "when hæmorrhage stops of its own accord, it is neither from the retraction of an artery, nor the con-

* *Mém. de l'Acad. Roy. des Sciences de l'année* 1736.

† *Operations in Surgery*. Third edition. Introduction, p. ii.

‡ *Mélanges de Chirurgie*, p. 331.

‖ *Cases and Practical Remarks in Surgery*, vol. ii. p. 352. Second edition.

§ *Cases in Surgery*, p. 171.

¶ *An Essay on the Ligature of Arteries*, by J. Aikin, in White's *Cases in Surgery*, p. 187.

** *Essay on the Methods of Suppressing Hæmorrhages from Divided Arteries.*

striction of its fibres, nor the formation of clots, but by the cellular substance which surrounds the artery being injected with blood*."

Most of these theories ascribe the suppression of hæmorrhage to one particular cause; but the elaborate experiments of Dr. Jones prove that this object is the effect of several concurrent and successive operations. The retraction and constriction of the artery, the formation of a plug at its mouth, the inflammation and consolidation of its extremity by an effusion of coagulating lymph within its canal, between its tunics, and in the cellular substance surrounding it, all concur in the accomplishment of this object. "An impetuous flow of blood, a sudden and forcible retraction of the artery within its sheath, and a slight contraction of its extremity, are the immediate and almost simultaneous effects of its division. The blood is effused into the cellular substance between the artery and its sheath, and passing through that canal of the sheath which had been formed by the retraction of the artery, flows freely externally, or is extravasated into the surrounding cellular membrane in proportion to the open or confined state of the external wound. The retracting artery leaves the internal surface of the sheath uneven by lacerating or stretching the cellular membrane

* *Principles of Surgery*, vol. i. p. 179.

that connected them. These fibres entangle the blood as it flows, and thus the foundation is laid for the formation of a coagulum at the mouth of the artery, and which appears to be completed by the blood, as it passes through this canal of the sheath, gradually adhering and coagulating around its internal surface, till it completely fills it up from the circumference to the centre. A coagulum, then, formed at the mouth of the artery, and within its sheath presents the first complete barrier to the effusion of blood. The mouth of the artery being no longer pervious, nor a collateral branch very near it, the blood just within it is at rest, coagulates, and forms, in general, a slender conical coagulum, which neither fills up the canal of the artery, nor adheres to its sides, except by a small portion of the circumference of its base, which lies near the extremity of the vessel. In the mean-time the cut extremity of the artery inflames, and the vasa vasorum pour out lymph, which is prevented from escaping by the external coagulum. This lymph fills up the extremity of the artery; is situated between the internal and external coagula of blood; is somewhat intermingled with them, or adheres to them; and is firmly united all round to the internal coat of the artery. The permanent suppression of the hæmorrhage chiefly depends on this coagulum of lymph:

but while it is forming within, the extremity of the artery is farther secured by a gradual contraction which it undergoes, and by an effusion of lymph between its tunics, and into the cellular substance surrounding it; in consequence of which these parts become thickened, and so completely incorporated with each other, that it is impossible to distinguish one from the other: thus not only is the canal of the artery obliterated, but its extremity also is completely effaced and blended with the surrounding parts*."

The means by which the hæmorrhage from a lacerated artery is suppressed, are the same as when an artery is wounded or divided with a cutting instrument. It is well known that the bleeding from a lacerated artery is generally less considerable than when an artery is wounded or cut across. This circumstance probably depends upon the lacerated vessel being torn to some extent from its immediate connexions, in consequence of which the blood becomes immediately entangled in the cellular structure which connects the artery to its sheath, so that the external coagulum, which constitutes the first barrier to the hæmorrhage, is speedily formed. Dr. Jones found that when an artery was torn across, the retraction of its extre-

* Jones *on Hæmorrhage*, chap. i. sect. iii. p. 53.

mities was not greater than when it was divided with a knife; but he observed that the sheath of the vessel was more extensively injected with blood, and that the external coagulum was more speedily formed*. When an artery is stretched and dragged from its connexions, as well as torn across, the internal and middle coats are lacerated in various parts; and Dr. Jones observed that the internal coagulum was very extensive. Under similar circumstances it has been remarked, that the lacerated extremity of the vessel was remarkably constricted†.

From the experiments of Dr. Jones it appears that the constriction and retraction of the artery, and the formation of a coagulum of blood over the mouth of its divided extremities, are the pri-

* Jones *on Hæmorrhage*, chap. i. sect. ii. experiments v. and xii.

† "A soldier of the Portuguese artillery was wounded in the breaching battery at Ciudad Rodrigo by a large piece of shell, which carried away his arm, splintering the humerus to its tuberosities, and grazing his side severely. Part of the long muscles of the arm remained, and the humeral artery hung down two inches and a half below the ridge of the pectoralis major, which retained its attachment to the shattered bone: it was independent of, or unaccompanied by the veins or nerves, and pulsated so forcibly to its very extremity, that, being wet, it felt inclined to slip from a loose hold of my fingers: the last eighth of an inch was contracted

mary means by which hæmorrhage is suppressed. The inflammation and effusion of lymph by which the permanent obliteration of the tube is effected, are the natural consequences of the injury inflicted upon the coats of the vessel. With a reference to these principles I shall consider the operation of the artificial means which have been employed for the suppression of hæmorrhage.

The impulse with which the blood is driven on counteracts the retraction and constriction of the artery, and impedes the formation of a coagulum at the mouth of its divided extremities. A languid state of the circulation is therefore necessary for the accomplishment of the natural means by which hæmorrhage is suppressed *. The occurrence of fainting, by suspending the circulation, allows the

in diameter, so much so as nearly to close the orifice of the vessel, which was of the size of a common pin's head, and that shut up by a little blood, a very thin layer of which covered the extremity of the vessel. On compressing the artery and again permitting its action, and this frequently, the impulse given to the blood thus advantageously, failed to remove the obstruction to its issue. This was about an hour after the accident, and the remains of the arm were removed without delay." — *Observations and Cases of Gunshot Wounds.* By G. J. Guthrie, Esq., Staff Surgeon with the Army in Portugal, in the *New Medical and Physical Journal*, vol. iv. p. 269.

* Jones *on Hæmorrhage*, p. 57.

constriction and retraction of the artery, and the formation of a coagulum at its extremity. Fainting, therefore, promotes the accomplishment of the natural means by which hæmorrhage is suppressed; and thus what appears to be the most alarming effect of the accident, is in fact the first means of reparation. Upon this principle also is to be explained the efficacy of venesection in the suppression of internal hæmorrhages.

The retraction and constriction of the extremity of a divided artery are not alone sufficient to close the tube and stop the flow of blood, although they promote the formation of a coagulum over the mouth of a divided artery. The efficacy of those remedies which have been denominated styptics, most of which were employed with the intention of promoting the contraction or retraction of the divided vessel, is therefore very inconsiderable, and in general their operation may be referred to principles which I shall consider hereafter. It is possible however that some of these applications, by accelerating the formation of coagulum, may tend to suppress hæmorrhage. Thus the employment of cold washes, and the exposure of bleeding surfaces to the atmosphere, frequently stop the flow of blood. How far the employment of stimulating or astringent solutions may promote the constriction or retraction of the artery, or the formation

of coagulum, is not capable of being determined from the observations which have hitherto been made upon this subject.

It sometimes happens that parts divided in surgical operations do not at the moment afford much hæmorrhage, and an attempt is made to effect the union of the surfaces by retaining them in contact with adhesive straps and bandages. In a few hours the part inflames; and vessels, which in their natural state conveyed but a small stream, become dilated, and afford a copious hæmorrhage. From this cause bleeding frequently occurs a few hours after the amputation of a limb, or the removal of a testicle, or diseased breast, although the principal arteries were tied, and the flow of blood was stopped at the time of the operation. Under these circumstances the hæmorrhage appears to be the consequence of the dilatation which the smaller arteries undergo during inflammation; and it is evident, that whatever tends to increase or keep up the inflammatory action of the vessels, will prolong the hæmorrhage. A frequent cause of excessive vascular action in recent wounds is the employment of compresses, tents, and tight bandages. When hæmorrhage appears to arise from the cause which I have now mentioned, the treatment should consist in the employment of such means as tend to diminish vascular action; namely, the removal

of all irritating applications, the use of evaporating washes, and the observance of general tranquillity*.

The cauterization of the wounded vessel is the most ancient remedy that has been employed for the suppression of hæmorrhage. The immediate effect of caustic applications is the formation of an eschar, which, by extending over the mouth of the divided vessel, prevents the escape of blood. A plug of coagulum forms within the artery, the extremity of which speedily inflames, and pours out coagulating lymph, by which the adhesion of its sides and the permanent obliteration of its canal are effected. Upon the separation of the eschar the extremity of the vessel is in a similar condition to that of an artery immediately after the detachment of a ligature. It occasionally happens, however, that, upon the separation of the eschar, the adhesion at the extremity of the artery is not accomplished, and hæmorrhage is renewed. The histories of the hæmorrhages which followed the employment of caustic are most dreadful; and at present this remedy is never employed where it is possible to have recourse to the more certain effects of the ligature or compression.

The operation of what has been termed the

* This doctrine is delivered by Mr. Abernethy in his Lectures.

potential is the same as that of the actual cautery. Many of those remedies which are denominated styptics are unquestionably caustics, and their efficacy is to be explained upon the same principle. The most celebrated of these applications consist of strong solutions of mineral acids, or of substances which are commonly employed as caustics.

Although the application of caustic is justly abandoned in all instances in which it is possible to employ compression or the ligature, yet in some hæmorrhages from minute arteries it is the most efficacious remedy. When the bleeding from the bites of leeches is not capable of being arrested by compression or mild styptics, the application of caustic, so as to form an eschar over the bleeding surface, will generally accomplish that object; and in hæmorrhagic constitutions, in which the slightest puncture is followed by serious bleeding, it is sometimes a necessary application. In profuse hæmorrhages from various fungi, scorbutic ulcers, and after the operation of cupping, the conversion of the surface into an eschar is sometimes the only mode of stopping the flow of blood.

The compression of the wounded artery is the first and most natural indication for the suppression of hæmorrhage. The flow of blood through the opening in the vessel is thus immediately arrested: the blood coagulates in its extremities and the surrounding cellular sheath, so as to form clots

which afford a temporary barrier to the hæmorrhage, and allow the accomplishment of those processes by which the canal of the vessel is permanently obliterated, or the wound in its coats united.

Two modes of applying compression have been employed in the treatment of wounded arteries. The first consists in bringing the edges of the external wound in contact, and applying compresses upon the integuments above the wound, and in the course of the artery: these compresses are firmly bound down by a circular roller. The second method consists in introducing a compress of sponge, agaric, or lint, into the bottom of the wound, so as to press directly upon the orifice in the artery, and prevent the escape of blood: the external wound is then filled with graduated compresses, which are retained in that position by a common bandage. The first method is liable to effect the adhesion of the external wound, without causing the union of the wound in the artery, or the obliteration of its divided extremities, so that the blood may escape into the surrounding parts, and the formation of an aneurism be the consequence. When the second method is adopted the compresses are very liable to be displaced. In both methods the employment of circular bandages impedes the establishment of the collateral circulation, and produces pain and swelling of the limb.

When a large artery is wounded in a situation in which it is impossible to employ the ligature, it appears to me preferable to introduce a tent into the wound, so as to block up the opening in the vessel in the manner which I have described. Sponge, lint, or agaric, are suitable applications for this purpose. When the hæmorrhage proceeds from an artery which is lodged in a bone, as the nutrient arteries of the bones of the extremities after amputations, or the branches of the alveolar artery after the extraction of a tooth, a pellet of softened wax forms a convenient and efficacious plug. If compression be employed when an artery is punctured, and the wound is very small, as when the brachial artery is wounded in the operation of venesection, it is necessary to close the external wound, and to apply the compresses upon the integuments.

The uncertainty of the effect of those means which I have hitherto mentioned renders the ligature of the vessel the most secure mode of treating wounded arteries. In a former part of this Treatise I have considered the operation of the ligature in general, and the best mode of its application *: I shall now offer a few observations which relate to its employment in wounded arteries.

In every instance in which an artery of con-

* See page 191.

siderable size is wounded, each extremity of the vessel should be tied as near as possible to the wound in its coats. The necessity of tying both ends of a wounded artery is evident from the fact that the anastomoses in all parts of the body are so extensive as to furnish a supply of blood, which may pass through the lower extremity of the wounded vessel in a sufficient stream to produce an alarming, and, in some instances, a fatal hæmorrhage. In the following case, which was communicated to me by Mr. Lawrence, the bleeding from the lower extremity of a divided brachial artery was sufficient to cause the death of the patient.

CASE XLIV.

A MAN was brought into St. Bartholomew's Hospital who had received in a quarrel a stab in the right thigh, and a deep cut in the lower and inner part of the right arm. When he received the latter wound his arm suddenly dropped, and hung useless by his side. A profuse hæmorrhage immediately took place, and was stopped with some difficulty by a surgeon who was accidentally present, and who tied the bleeding vessel. On the arrival of the patient at the hospital he was in a cold and almost senseless state, for which suitable cordials were administered. A ligature

was observed in the wound, and no bleeding took place from any quarter: the edges of the incision were therefore brought together in the usual manner. On the next and on the following days the patient had recovered considerably from the bleeding: his pulse could be plainly felt at the wrist of the wounded arm, and the wound itself appeared to have united by adhesion. Every thing went on favourably until the evening of the sixth day after the accident, when bleeding took place from the arm, and proceeded to such an extent before it was observed by the patient or discovered by the nurse, as to soak through the bed. When the wound was opened no bleeding vessel could be discovered. Hæmorrhage came on again early in the following morning; and although the effusion was not so great, it sufficed, after the debilitating effects of the former bleedings, to exhaust the powers of life. The patient died about twelve o'clock on the seventh day after the accident. The ligature which had been placed on the bleeding vessel in the first instance, came away on the day preceding that on which the patient died.

The incision had commenced about three inches above the elbow, on the front of the arm, and had continued obliquely downwards and inwards in a direction towards the internal condyle of the humerus, penetrating nearly to the bone in its

whole course. It had divided the biceps flexor cubiti, with the exception of a few fibres of its exterior margin: a part of the brachialis internus: the brachial artery, with its attendant veins: the median and the internal cutaneous nerves. The upper end of the divided artery was firmly closed. The lower orifice contained a small portion of apparently recent coagulum, not adhering closely, nor completely filling the orifice.

In this case it is evident that the bleedings which constituted the cause of death came from the lower end of the artery, and consequently that this end should have been tied at the time of the accident.

The ligature of an artery at a distance from the wound in its coats, or of a trunk when a branch is wounded, will not in general secure the patient from hæmorrhage; for the blood will either flow from the lower end of the artery, or from the upper, into which it will enter through branches which open into the trunk between the ligature and the wound. Many surgeons have recommended, when an artery is wounded in a situation in which it is difficult to secure the extremities of the bleeding vessel, that the trunk should be tied in a part of the limb where it can be exposed with facility. This practice was falsely deduced from a knowledge of the fact, that the ligature

of an artery at a distance from the disease will effect the cure of an aneurism. But a more intimate acquaintance with the condition of a limb after such an operation, and the processes by which the cure of an aneurism is effected after the modern operation, afford a complete illustration of the inefficacy and danger of this mode of treating a wounded artery; for it is now fully proved, that when an artery is tied a stream of blood continues to pass through it below the ligature*. I am indebted to Mr. Henry Earle for the notes of the following case, which show the inefficacy of tying a main artery when a principal branch is wounded.

CASE XLV.

A WOMAN in a fall thrust her arm through a pane of glass, and received a punctured wound about midway between the elbow and wrist. A violent hæmorrhage followed, but the flow of blood was stopped by pressure. A tumour formed gradually. About three weeks after the accident there was an extensive swelling underneath the external wound, which was not more than half an inch in length, and was at this time closed by a scab. The swelling had an evident pulsation,

* See page 266.

and the patient had twice lost a considerable quantity of blood upon the separation of the scab. A third hæmorrhage took place, when the brachial artery was tied in the middle of the arm with two ligatures, and was divided in the interspace. About a quarter of an hour after the operation a slight pulsation was distinctly perceptible in the radial and ulnar arteries, and in half an hour it was very evident in the swelling. Compresses, moistened with cold washes, were applied to the swelling: it continued to pulsate, but did not increase in size. On the eighth day after the operation the scab again slipped off, and a copious bleeding took place. It was now determined to tie the artery at the part where it was wounded. A tourniquet was applied to the arm, and the tumour was freely opened. It contained a large quantity of grumous blood, but no lamellated coagulum: at the bottom of the cavity the radial artery was found half divided. On loosening the tourniquet the blood flowed freely from both ends of the wounded vessel. Both extremities of the artery were tied, and its entire division effected. The wound at first sloughed, but afterwards did well, and in six weeks the woman completely recovered. The pulsation of the ulnar artery was at that time as strong as in the corresponding artery of the opposite limb: in the radial it was rather more obscure; but about a year after the accident no

difference was perceptible in the pulsation of the arteries of the two arms *.

I am aware that instances have occurred in which only the upper end of a wounded artery has been tied, and the patient has recovered with-

* The following case, which is recorded by Mr. Guthrie, so strongly illustrates the danger of trusting to the ligature of the trunk when a principal branch is wounded, that I take the liberty of quoting it:—"Thomas Carryan, of the third regiment, on the 16th of May, at Albuhera, was wounded on the inside of the calf of the right leg, the ball passing out on the fore and outside of the tibia; it bled considerably at the moment, and continued for some minutes; when ceasing, it did not return until the 15th of June, on which day a little blood followed the dressings, and increased on the patient making any exertion; so that on the 4th the gentleman under whose care he was tied the femoral artery on the outside of the sartorius muscle, which suppressed the hæmorrhage for that day, the limb continuing, with little or no interruption, of the same temperature to the hand as the other: on the 5th the original wound had a bad appearance, and some coagulated blood was readily pressed out of it: on the 6th a greater quantity came away: and, on the 7th, the exertion of using the bed pan was followed by a stream of arterial blood, which ceased on tightening the precautionary tourniquet. The limb was amputated above the ligatures on the artery: the dissection showed the anterior tibial artery to have been destroyed for some distance, and the muscles on the back part of the leg nearly in a gangrenous state. Another case occurred with precisely the same termination; the wound was in the fore-arm, and the humeral artery secured."—*New Medical and Physical Journal*, vol. iv. p. 181.

out hæmorrhage from the lower extremity of the vessel*. In such cases the lower extremity of the vessel must have been closed by the natural processes. It sometimes happens when hæmorrhage takes place a few days after the bleeding from a wounded artery has been stopped by compression in the first instance, that one extremity of the vessel will be pervious, whilst the other will have been closed by the natural processes. Cases have even occurred in which the upper end of the artery has been closed by the natural processes, whilst those processes have failed in

* See BELL, *Principles of Surgery*, vol. i. p. 187. Since this section was written I have received a letter from Dr. Macartney, Professor of Anatomy in the University of Dublin, from which I am induced to insert the following extract, because it is gratifying to me to find that the preceding observations are corroborated by his experience. "I have seen many examples of a ligature applied to the trunk of an artery being ineffectual with respect to a wounded branch; and not unfrequently the patient, after repeated unavailing attempts to suppress the hæmorrhage, has lost his limb, or perhaps his life. The practice of tying the trunk in preference to the wounded branch seems to have arisen from the success attending the modern operation for aneurism: but the history of that disease ought rather to have taught us the insufficiency of securing the trunk for the purpose of destroying the circulation through its branches: it should also have led us to foresee the necessity which commonly exists for putting a ligature on each side of the divided branch of an artery."

effecting the obliteration of the lower extremity of the vessel, from which a serious hæmorrhage has taken place *. When the bleeding from a

* " Private J. Barnes, 29th regiment, on the 16th of May, at the battle of Albuhera, received a musket ball in the right leg, behind and above the knee, inclining downwards and inwards, close to the condyles of the femur, and in the direction of the femoral artery, becoming popliteal, which bled violently at the moment, and continued for a few minutes, during which time he conceives he lost two quarts of blood; it then ceased, and he was dressed in the usual slight manner, and remained two days upon the field of battle, until conveyed to Valverde, nine miles, on a bad road and on men's shoulders, in a blanket converted into a bearer; being considered as one of the slightest cases, until the gentleman in immediate charge of him requested me to see him, on account of his toes being in a state of mortification, which was considered to point out a more serious injury than was at first supposed. On the evening of the third of June, eighteen days after the accident, this man was placed on a bullock car, to be removed with the rest of the wounded to Elvas; the mortification in the foot having ceased to increase, a line of separation being drawn. Shortly after the cars moved, I had the mortification to be informed he was bleeding from the wound; it evidently appeared to be the popliteal artery; and as it flowed slowly, I supposed from the lower divided end. The situation of the wound making the dissection difficult, and the foot being partly lost, I determined on amputation above the knee, which was performed at Olivença. I caused the amputated limb to be sent after me to Elvas, that I might examine it at my leisure. I carefully traced the course of the wound, and found in it a little coagulated blood, but could not see the mouth of

wounded artery is stopped by the ligature of the trunk at a distance from the wound, it is probable that the diminution of the force of the circulation at the extremities of the wounded vessel allows

the vessel. A probe passed into the amputated end of the artery was obstructed before it reached the ulcerated surface, by near an inch; and on passing it up the lower one it was stopped exactly in the middle of the track of the ball by a veil or substance drawn across the mouth of the vessel, and which, on careful examination, showed the point of the probe at one part of the circle, although too small to let it through, and from which I conceive the hæmorrhage came: the divided ends now closed were one inch apart; each portion was cut out with the ulcerated spot on which they terminated, and opened in their course. The upper, or femoral portion, for near an inch, was filled with a firm coagulum, filling up the contracted mouth of the vessel, like the gradual diminution of the neck of a claret bottle; a layer of the same covers the mouth and immediate vicinity, and appears to have a commencing organization; the vein was cut, and is closed in the same manner: and I think the whole shows very clearly the process employed by nature, without the aid of art, to heal a large artery when fairly divided. The lower or popliteal portion is very peculiar; the substance drawn across appears to me to have closed it completely at one time, and to have given way from the rough motion of the car at the point now open, and which is very small, when the sides of the artery are even now approximated; a very little soft coagulum was behind it, and, if the man had not been removed, I think the vessel would have remained secure." — GUTHRIE's *Observations and Cases of Gunshot Wounds, in the New Medical and Physical Journal*, vol. iv. p. 177.

the accomplishment of those processes, which could not take place whilst the parts were exposed to the undiminished impulse of the circulating blood. Although it is possible, when the upper extremity of a wounded artery is tied, that the lower may be closed by the natural processes so as to prevent the occurrence of hæmorrhage, yet the frequent failure of the natural processes justifies our regarding it as a rule in practical surgery, that in every instance in which an artery of sufficient magnitude to afford a serious hæmorrhage is wounded, both extremities of the vessel should be tied as near as possible to the wound in its coats.

The difficulty of compressing a punctured artery so as to place its wounded edges in a state of accurate contact, and yet not to obliterate the canal of the vessel, is so great as rarely to allow us to heal the wound, and yet retain the continuity of the tube; and the chance of hæmorrhage, or the formation of an aneurism, is so great when this treatment is adopted, that it is safer to tie the vessel than to trust to the compression of a punctured artery. Nor indeed would any desirable object be gained by preserving the canal of the vessel; for it is fully proved that every part of the body is provided with the means of carrying on a collateral circulation, and that in general there is no danger of a deficient supply of blood when a main artery is tied in a healthy limb.

In a former part of this Treatise I have mentioned those circumstances which may impede the establishment of a collateral circulation after the operation for aneurism*: the same observations may be applied to the condition of a limb after the ligature of a wounded artery. It must be acknowledged, however, that the mortification of the limb is a more frequent occurrence after the ligature of a wounded artery, than when an artery is tied for the cure of an aneurism. This circumstance appears to be sometimes owing to the injury which the surrounding parts, and more particularly the veins and nerves, have sustained from the accident: in some instances it may arise from the debility induced by excessive loss of blood, or the want of quietude and care after the accident. When the wound by which a main artery is divided is so extensive as at the same time to destroy the principal anastomosing branches, the establishment of a collateral circulation will of course be impeded. I have known an instance in which mortification of the fore-arm followed the division of the brachial artery by a deep wound which extended down the inside and round the back of the arm; but in another instance in which the brachial artery and all the parts in

* See page 259.

the front of the arm were divided, the limb was preserved. In the latter case the principal anastomosing channels were not divided, but in the former the opposite direction of the injury had caused their obliteration.

SECTION II.

ON ANEURISMS ARISING FROM WOUNDED ARTERIES.

When an artery is wounded, and the wound in the integuments is closed by compression so as to prevent external hæmorrhage, it sometimes happens that the blood is extensively injected into the cellular membrane surrounding the artery, and connecting the different parts of the limb, forming that variety of the disease which is termed a diffused aneurism. When an artery is wounded by an instrument which passes into the limb obliquely, so that the wound in the artery is not opposite to the wound in the integuments, or when an artery is torn asunder by violent extension, or lacerated by the extremity of a fractured bone, a diffused aneurism sometimes takes place. This accident is also sometimes the consequence of the rupture of an aneurismal sac underneath the integuments *.

* I have also known two cases in which diffused aneurisms were produced by the rupture of aneurisms of the aorta. In one of these cases the sac burst into the mediastinum; in the other into the mesentery. In both instances the cellular structure contained in these parts was extensively injected with blood. The patients lived some time after the rupture

A diffused aneurism is an ecchymosis arising from a large artery: in proportion to the size of the vessel, and of the wound in its coats, are the rapidity and extent to which the extravasation proceeds. In some instances the cellular system of a whole limb has been injected with blood, and mortification has taken place in a few hours: in other instances the resistance of the surrounding parts has limited the extravasation, and the hæmorrhage has been stopped by the blood coagulating and forming a clot over the orifice in the artery.

The treatment of a diffused aneurism should be the same as that of a recently wounded artery attended with external hæmorrhage. The only difference between the two cases is, that in the latter the blood flows externally, whilst in the former it is injected into the cellular membrane. In a diffused aneurism, therefore, both extremities of the vessel should be tied as near as possible to the wound in its coats. This operation, however, is sometimes attended with considerable difficulty, for the extravasated blood displaces the surrounding parts, and the mouth of the wounded vessel is

of the aneurismal sacs, and their symptoms indicated the moment at which this event took place. At length the pleura gave way in one, and the peritoneum in the other, and fatal hæmorrhages into the cavities of the abdomen and thorax were the consequences.

concealed by cellular membrane filled with blood. Having divided the integuments, and sponged out the blood, the operator should search for the wound in the artery, into which a probe may be introduced, so as to enable him to detach the vessel with accuracy from the surrounding parts. Both extremities of the artery being tied, the blood should be pressed out of the cellular membrane into which it has been injected, in order to diminish as much as possible the extent of the suppuration which is the general consequence of this injury.

In the last Section I have observed that when an artery is punctured or partially divided the hæmorrhage is sometimes arrested by the formation of a layer of coagulum over the orifice in the vessel, and that the edges of the wounded artery are subsequently united by an effusion of lymph, in the same manner as wounds in soft parts in general are healed by the adhesive inflammation *. This mode of reparation, by which the continuity of the tube is preserved, takes place more readily when an artery is wounded in a longitudinal direction, than when the wound is transverse or oblique; for in the latter cases the retraction of the artery causes the orifice in its coats to assume a circular form, in consequence of which the effusion of lymph is greater than

See page 455.

when the edges of the wound are in a state of contact*. The lymph which is in this manner effused from the edges of a wounded artery does not appear to possess the same power of resisting the impulse of the circulating blood as the natural boundaries of the tube; for it occasionally happens that, some days, or even weeks after the accident, this lymph is torn through or forced out of the orifice in the artery, so that the blood comes in contact with the surrounding parts, which it gradually distends into an aneurismal sac. It appears also probable, that in some instances the lymph is first dilated into a small pouch, which ultimately gives way, and then the surrounding parts form the sac in the manner which I have described. In either of these cases the formation of a circumscribed aneurism is the consequence †.

The failure of the processes by which Nature effects the obliteration of a divided artery, may give rise to the formation of a circumscribed aneurism. In a few days after the accident the union of the external wound prevents the blood

* See JONES *on Hæmorrhage*, p. 114.

† Aneurisms arising from wounded arteries have been termed false or spurious aneurisms. When the extravasation is diffused, it has been termed a diffused false aneurism; when circumscribed, a circumscribed false aneurism. The French writers term the former, *anévrisme faux primitif;* and the latter, *anévrisme faux consécutif.*

from passing into the cellular membrane, so as to form a diffused aneurism; but if, at this time, the adhesion at the extremity of the divided vessel be not accomplished, the impulse of the blood against the parts immediately surrounding the artery will gradually separate and distend them into an aneurismal sac. When an artery is wounded, compression is sometimes employed, so as to stop the circulation through the vessel until the external wound is united. When this object is effected, the compression is omitted, and if the adhesion at the extremity of the vessel be not sufficiently firm to resist the impulse of the circulating blood, the formation of an aneurism commences. In some instances the formation of an aneurism has been the consequence of incautiously moving the limb soon after the accident, by which the adhesion at the extremity of the vessel has been torn asunder; and cases have occurred in which an aneurism has been the consequence of the ulceration or sloughing of the extremity of a wounded artery. When an artery is wounded by a musket ball, the hæmorrhage at the moment is sometimes very inconsiderable, and the external wound is closed in the usual manner. In a few days a slough separates from the artery, and the external wound being united, the blood comes in contact with the surrounding parts, which it distends into an aneurismal sac. The same event sometimes takes place upon the

separation of the slough which is formed by the passage of a musket ball in the vicinity of an artery, although the coats of the vessel were not wounded at the time of the accident*. The formation of a circumscribed aneurism is also sometimes the consequence of the laceration of an artery by violent exertion, or of its being wounded by the extremity of a fractured bone†.

This kind of aneurism is most frequently produced by a wound of the brachial artery in the operation of venesection. Instances, however, are recorded in which circumscribed aneurisms have been the consequence of wounds of almost all the arteries of the extremities. Guattani‡ and Pelletan‖ relate cases in which aneurisms appeared to be the consequence of sword wounds of the aorta.

In every instance in which an artery is wounded, it is safer to employ the ligature than to trust to the chance of obliterating the vessel, or of effecting the union of its divided edges by compression. When, however, compression is em-

* A case of aneurism arising from a gunshot wound in the thigh is recorded in DESAULT'S *Journal de Chirurgie*, tom. ii. p. 112.

† Cases of aneurism arising from arteries wounded by fractured bones, are related by WHITE, *Cases in Surgery*, p. 141.—BELL'S *Principles of Surgery*, vol. i. p. 337, 368.—PELLETAN, *Clinique Chirurgicale*, tom. i. p. 178.

‡ *De Externis Aneurismatibus*, hist. xxvi. p. 102.

‖ *Clinique Chirurgicale*, tom. i. p. 92.

ployed, it is advisable that it be continued for some time after the union of the external wound, for the purpose of affording support to the lymph which closes the opening in the vessel. When a large artery is wounded, the profuse bleeding which generally ensues diminishes the force of the circulation, and allows the accomplishment of the first processes by which the hæmorrhage is suppressed. In a short time the force of the circulation returns, and if the lymph has not acquired sufficient firmness to resist this impulse, it is liable to be torn asunder or dilated, so as to form an aneurismal sac. Hence the force of the circulation should be moderated for some time after the accident by depletion and abstinence, and the danger of the adhesion being torn asunder by the incautious exertions of the patient should be obviated by perfect tranquillity*.

The blood deposits layers of coagulum in aneurismal sacs which arise from wounded arteries, and this variety of the disease sometimes undergoes a spontaneous cure in the same manner as that which arises from a morbid condition of the coats of the vessel. This event took place in the following case, which occurred a few years ago in the practice of my friend Dr. Gooch.

* See JONES *on Hæmorrhage*, p. 119.

CASE XLVI.

A BOY about nine years of age fell down with an earthern plate under his arm, one of the long pointed fragments of which pierced his left axilla. He was instantly covered with blood, and fainted. The surgeon who was called to him bound up the axilla, and a few days afterwards, on removing the dressings, the wound was found to be healed. There was, however, in the bottom of the wound some degree of fulness, attended with pulsation. The pulsation and swelling gradually increased, and in a few weeks the tumour had acquired such a size that it projected out of the hollow of the axilla. It never attained any larger dimensions, but became solid, and gradually decreased. Eight months after the accident the pulsation was scarcely perceptible in it, and the pulse at the wrist was extremely feeble. At length the tumour entirely lost its pulsation. Eighteen months after its commencement no vestige of the disease remained, and the boy had recovered the strength and use of his arm *.

An aneurism arising from a punctured artery

* A case of aneurism arising from a wounded artery, which underwent a spontaneous cure, is recorded by BLAGDEN, in *Medical Facts and Experiments*, vol. ii. p. 48.

sometimes becomes filled with lamellated coagulum, which seals up the orifice through which the sac communicated with the artery, and the cure of the disease is accomplished without the canal of the vessel being obliterated. The coagulum is absorbed, the sac contracts, and the orifice in the artery is permanently closed. This mode of cure in aneurisms arising from punctured arteries is similar to that which I have described as sometimes taking place in aneurisms which are produced by a morbid condition of the vessel; and I refer the reader to a more full account of the process in the Section on the Spontaneous Cure of Aneurism *. Saviard †, Petit ‡, Foubert ‖, Scarpa §, and Jones ¶, have recorded observations which illustrate this mode of cure in aneurisms arising from wounded arteries. In some of the cases related by these writers the sacs were filled with firm coagulum, which sealed the opening in the artery without extending into the canal of the vessel. In one case Scarpa observed that the wounded edges of the artery had adhered, and that a mere line of cicatrization was discoverable when the artery was

* Page 117. † *Observations in Surgery*, obs. lxi.

‡ *Traité des Maladies Chirurgicales*, tom. iii. p. 218—220.

‖ *Mém. de l'Acad. Royale de Chirurgie*, tom. ii. p. 542, 543.

§ *Treatise on Aneurism*, WISHART's *Translation*, p. 345—349.

¶ *Treatise on Hæmorrhage*, chap. ii. sect. i. exp. VIII.

slit open. The coagulum, in this manner shut out from the canal of the vessel, formed a small tumour, which was attached to the outside of the artery*. When, however, a spontaneous cure takes place in an aneurism arising from an artery which has been extensively wounded or completely divided, it is probable that the canal of the vessel is obliterated.

The same modes of treatment should be adopted in aneurisms arising from wounded arteries as in those which are the consequence of a morbid condition of the coats of the vessel. The diminution of the force of the circulation by depletion, abstinence, and quietude, may be advantageously employed in promoting the spontaneous cure of aneurisms arising from wounded arteries. Sabatier relates the history of an aneurism in the axilla produced by a sword wound, which was permanently cured by a rigid perseverance in this debilitating treatment†.

Compression has been strongly recommended in the treatment of circumscribed aneurisms arising from wounded arteries; and numerous instances are recorded in which it is said to have been advantageously employed. The records of surgery abound in descriptions of instruments invented for

* *Treatise on Aneurism*, WISHART's *Translation*, p. 352.

† *Médecine Operatoire*, tom. iii. p. 170.

the purpose of compressing this kind of aneurism, with the intention of preventing the passage of the blood through the wound in the artery. A perusal of many of those cases in which compression is said to have effected the cure of this disease, has, however, convinced me that this mode of treatment cannot be relied upon with a greater prospect of success for the cure of aneurisms arising from wounded arteries, than when the disease is the consequence of a morbid condition of the coats of the vessel; and from the observations contained in a former part of this Treatise *, I think it is evident that compression is rarely capable of effecting the cure of this disease. When, however, the process of spontaneous cure is going on, and coagulum is accumulating in the sac, compression, by enabling the parts to resist the impulse of the circulating blood, may prevent the increase of the tumour. Foubert relates a case of aneurism of the brachial artery in which the processes of spontaneous cure were going on favourably during the employment of compression. The patient, however, left off his bandages, and the tumour increased so rapidly as to render an operation necessary †. Saviard mentions an instance in which the tumour increased, and required an

* Page 166.

† *Mémoires de l'Acad. Royale de Chirurgie*, tom. ii. p. 540.

operation, after having remained stationary twenty years *.

The ligature of the artery is the most effectual mode of curing this as well as every other kind of aneurism, when the situation of the disease renders the operation practicable. In aneurisms arising from wounded arteries the old operation of opening the sac and tying both extremities of the vessel in that situation, is recommended and practised by many surgeons even of the present day. I cannot, however, avoid objecting to this practice; for I am not aware of any circumstance which precludes the application of the modern operation of tying the artery at a distance from the disease to this as well as to that kind of aneurism which arises from a morbid condition of the coats of the vessel. The necessity of tying both extremities of the wounded artery in diffused aneurisms has probably induced the idea that a similar practice is necessary in circumscribed aneurisms arising from wounded arteries. There is, however, a difference in the two cases, which justifies an important difference in their treatment. In diffused aneurisms, when the upper end of the artery is tied, the blood which flows from the lower extremity of the vessel is liable to be injected into the surrounding cellular membrane;

* *Observations in Surgery*, obs. lxi.

but the condition of a circumscribed aneurism arising from a wounded artery is similar to that of an aneurism produced by a destruction of the coats of the vessel from an internal cause; and the diminution of the force of the circulation through the sac, which is the consequence of tying the artery at a distance from the disease, will as inevitably produce those changes in the sac by which the cure is accomplished, in the one instance as in the other. The exposure of the cavity of an aneurismal sac arising from a wounded artery will generally be followed by extensive suppuration and sloughing; and, in short, the practice is open to all the objections which have been urged against the old operation for aneurism, except that the coats of the artery are not likely in these cases to be affected with those morbid alterations which generally exist in them, when an aneurism arises from an internal cause. It is only necessary to refer to cases in which aneurisms arising from wounded arteries have been cured by tying the artery above the tumour, without opening the latter, to prove that the principles of the modern operation for aneurism may be applied with as much success to the treatment of this variety of the disease as to that which is the consequence of a morbid condition of the coats of the vessel*.

* Cases of aneurism arising from wounded arteries which were cured by tying the artery above the disease without

The surgical treatment of circumscribed aneurisms arising from wounded arteries should, therefore, be the same as that of circumscribed aneurisms arising from other causes.

The observations contained in this and the preceding sections appear to me to justify the following practical deductions:

First: In every instance in which an artery of sufficient size to afford a dangerous hæmorrhage is wounded, it is advisable that both ends of the vessel should be tied as near as possible to the wound in its coats.

Secondly: The ligature of the upper end of a wounded artery, or of the trunk when a branch is wounded, will not in general secure the patient from hæmorrhage, which may take place either from the inferior extremity of the vessel or from the superior extremity into which the blood may pass through anastomosing branches which open into the trunk between the ligature and the wound.

Thirdly: In diffused aneurisms the ligature of both ends of the artery is as necessary as when the hæmorrhage from a wounded artery takes place externally.

opening the sac, are recorded by ANEL, *Suite de la Nouvelle Méthode de guérir les Fistules Lachrymales*, p. 251.— FREER, *Observations on Aneurism*, p. 54. — PELLETAN, *Clinique Chirurgicale*, tom. i. p. 178.

Lastly: In circumscribed aneurisms arising from wounded arteries it is unnecessary to open the sac and to tie both ends of the vessel in that situation; for the ligature of the artery at a distance from the tumour will as certainly effect the cure of this kind of aneurism as of that which is the consequence of a morbid condition of the coats of the vessel.

SECTION III.

ANEURISMAL VARIX AND VARICOSE ANEURISM.

When a vein is transfixed by a cutting instrument which at the same time pierces a subjacent artery so as to form a direct communication between the two vessels, through which the blood passes from the artery into the vein, and dilates the latter into a sac, the disease is termed aneurismal varix.

This disease is characterized by a small circumscribed bluish tumour, formed by a dilated vein, possessing a peculiar tremulous motion, and attended with a thrilling or hissing noise, which arises from the passage of the blood through a small opening in the artery into the dilated vein. The tumour is generally not larger than a nutmeg, and is accompanied with a varicose state of the neighbouring veins, extending a short distance up the limb. It disappears entirely upon pressure; and when the limb is elevated, so as to favour the return of venous blood towards the heart, it subsides, and the pulsation in it is diminished. But when the limb hangs down, or pressure is made in the course of the vein above the tumour, it enlarges and forms a considerable external swel-

ling. When the vein is compressed below the tumour, the pulsation and size of the latter are not diminished. When the artery is compressed above the tumour, the pulsation ceases immediately, and returns instantly when this compression is removed. The trunk of the artery above the varix is considerably enlarged, and its pulsation is stronger than in the opposite limb: but the pulsation of the arteries below the tumour is weaker than in the corresponding vessels of the opposite side of the body.

The enlargement of the artery above the tumour appears to be the effect of that property by which the size of arteries becomes adapted to that of the parts which they supply. The stream of blood which at each pulsation of the heart passes through the wound in the artery into the vein, is so much taken from the supply destined for the nourishment of the limb. To compensate for the stream which passes through the wound in its coats, the main artery enlarges in the same manner as an artery becomes dilated to supply a præternatural growth.

It is evident that an aneurismal varix may occur in any part of the body where an artery is situated in contact with a vein, but its most frequent seat is the bend of the arm, where it is the consequence of incautious venesection. Ex-

cepting two cases to which I shall refer hereafter, I am not aware that a single instance of the existence of this disease in any other part of the body has hitherto been recorded. It cannot, I think, be doubted that the following were cases in which this disease existed in the lower extremities. The first was communicated to me by Mr. Barnes of Exeter: the second I had an opportunity of seeing.

CASE XLVII.

A BLACKSMITH'S boy, about seventeen years of age, whilst at work, turned suddenly round, and the sharp end of an iron rod, nearly red hot, ran for some depth into the upper part of his thigh. A violent stream of blood, which immediately followed, was stopped by a fellow-workman pressing firmly on the orifice with his fingers: the wound was secured from further bleeding by a surgeon, who applied a compress and tight roller round the limb. These applications were continued about eight weeks, when the wound was healed. Ten weeks after the accident a tumour of a purple colour, about three inches in diameter, and not much elevated above the surrounding skin, was situated immediately over the femoral artery, about four inches below Poupart's ligament. This tumour was softer towards the centre than at its

circumference, but was compressible every where. It possessed a pulsation corresponding with the pulse at the wrist. The pulsation was accompanied with a peculiar thrilling or trembling motion, extending some distance both above and below the tumour, but more particularly upwards, being sometimes perceptible as high as the groin. This peculiar motion was also accompanied with a buzzing or rather hissing noise, which corresponded with the pulse in the arteries.

The symptoms were so peculiar, and the noise so like what Dr. Hunter describes, " as if there was a blast of air through a small hole," or " like what is produced in the mouth by continuing the sound of the letter R in a whisper*," that there could be no doubt of its being a case of aneurismal varix produced by the passage of the pointed iron through the femoral artery and vein.

The boy did not complain of coldness in the limb, nor was it to the touch colder than the other. He had not used it since the accident, having always kept the leg in a horizontal posture, and as quiet as possible, dreading another bleeding, for he was excessively alarmed by the great gush at the time he was wounded. He frequently

* *Medical Observations and Inquiries*, vol. ii. p. 403.

complained of a pain in the heel, extending up the outside of the leg to the ham. Neither pulsation nor hissing noise could be discovered in the ham. The noise was heard most distinctly by placing the ear over the tumour at the point where the iron entered. It was also very perceptible three or four inches above the tumour, though scarcely perceptible below it. It was determined in consultation to apply a laced bandage over the whole thigh, with a firm compress of cork covered with leather upon the tumour. The bandage was to be gradually tightened, and the limb moderately exercised. At the end of a month after this treatment was commenced, the boy could use his leg and walk tolerably well. The tumour was somewhat less, and the pulsation not so violent. He left the hospital, and was advised to learn a less laborious trade than that of a blacksmith.

CASE XLVIII.

A DRAGOON in an action in the East Indies received a pistol ball in his right ham. A violent gush of blood instantly filled his boot, and he fainted. When conveyed to the tent, some lint was put upon the wound: after the action a poultice was applied. A few days afterwards several pieces of wadding were extracted: the

ball had passed out by the side of the knee. In ten days he observed a pulsating swelling in the ham, which for a short time continued to increase. It then diminished, and assumed the condition which was observed when I saw him, eighteen months after the accident. At that time there was a flat, compressible, soft tumour in the lower part of the ham, attended with pulsation, or rather a tremulous motion, and conveying a hissing or thrilling sensation to the ear. It was not so large as an egg, and according to the man's account had remained in that state more than sixteen months. A common roller was applied round the knee: during the time that the patient remained under our care no alteration took place in the tumour.

I am induced to believe that this was a case of aneurismal varix, first, on account of the peculiar tremulous motion and noise which attended the pulsation of the tumour; and, secondly, because the tumour remained stationary, which we know to be very rarely the case in aneurisms, and more particularly when the disease is situated in the ham. The hæmorrhage in the first instance appears to have been stopped by the natural processes: it is probable that the artery and vein subsequently sloughed, and that in this manner a communication was formed between the two vessels.

Sabatier*, Richerand†, and Boyer‡, mention a case of aneurismal varix produced by a sword wound of the popliteal artery and vein. The preparation was given to the Academy of Surgery, with an account of the case, which has not been published. Richerand‖ says, that M. Larrey showed to the Faculty of Medicine a grenadier in whom this disease was situated underneath the clavicle, and was produced by a wound of the great artery and vein in that situation. It was attended with an evident trembling motion in all the superficial veins of the arm.

The tumour, which is speedily formed by the dilatation of the wounded vein, in a little time diminishes, when the neighbouring veins are dilated, so as to allow a free passage to the blood. The degree to which the dilatation of the neighbouring

* *Médécine Opératoire*, tom. i. p. 417.

† *Dictionnaire des Sciences Médicales*, art. Anévrisme Varicqueux.

‡ *Traité des Maladies Chirurgicales*, tom. ii. p. 177. Scarpa speaks of this case as mentioned by Lassus; but I have in vain looked for it in Lassus, *Pathologie Chirurgicale*. It is mentioned by Sabatier, to whom Scarpa refers, although Sabatier does not mention Lassus as having described it. Boyer says that it was observed by M. Larrey, a distinguished surgeon at Toulouse. I conclude that Scarpa and Boyer allude to the same case.

‖ *Dictionnaire des Sciences Médicales*, art. Anévrisme Varicqueux.

veins and the size of the tumour arrive, depends upon the extent of the wound by which the artery communicates with the vein, as this circumstance regulates the quantity of blood which the latter receives from the former. When the dilatation of the veins has proceeded to such an extent that these vessels are capable of containing the blood which is thrown into them at each pulsation of the artery, the size of the tumour becomes stationary. I am not acquainted with an instance in which the tumour has increased after this period, or in which the interference of surgery has been necessary. On the contrary, numerous instances are recorded in which this disease has remained stationary many years, and has afforded little or no inconvenience. Dr. William Hunter, who first described this disease*,

* See *Medical Observations and Inquiries*, vol. i. p. 340. and vol. ii. p. 390. Scarpa says, "Guattani at the same time as Dr. Hunter, or certainly before Dr. Hunter's investigations with regard to this particular kind of aneurism were known in Italy, had published the history of two cases of aneurismal varix, with regard to the true nature of which disease described by Guattani there cannot be the smallest doubt. It may therefore be said that he had an equal share in the merit of the discovery."—*Treatise on Aneurism*, WISHART's *Translation*, p. 390.—On this subject it may be proper to observe, that Dr. Hunter's observations on this disease were published in the years 1757 and 1764, whereas Guattani did not see his first patient until the year 1769, and his book

has related two cases, in one of which the tumour remained stationary fourteen, and in the other five years*. Dr. Cleghorn mentions a case in which this disease had continued in the same state five years†; and Mr. Benjamin Bell‡ says, that after twenty years, the only alteration which was observable in the arm of this patient was, that the veins communicating with the varix were a little more swoln. Dr. Hunter informed Mr. Benjamin Bell, that in the first case in which he observed this disease, it continued in the same state thirty five years after the patient received the injury. Mr. Bell mentions another instance of aneurismal varix which, thirteen years after its commencement, was attended with no inconvenience, although, during that time, the patient had been engaged in the laborious occupations of a sailor‖. Scarpa relates an instance in which, fourteen years after the accident, the tumour had not increased, and the patient did not suffer any inconvenience in the arm, except some transient numbness§. I have seen a case in which this

was not published until the year 1772. An instance of this disease is mentioned by Sennertus.— *Opera Omnia*, tom. v. lib. v. part 1. cap. 43.

* *Medical Observations and Inquiries*, vol. ii. p. 396, 400.

† Ibid. vol. iii. p. 110.

‡ *System of Surgery*, vol. iii. p. 199. note. Seventh edition.

‖ Ibid.

§ *Treatise on Aneurism*, WISHART'S *Translation*, p. 392.

disease had existed three years without undergoing the slightest alteration: many similar instances have been mentioned by surgical writers.

It is evident, that, should the tumour burst, the most secure mode of treating this disease would be to tie the artery both above and below the wound in its coats. I am not, however, acquainted with any cases in which this operation has been required; and the only mode in which the cure of this disease has been attempted has been by compression.

It is possible that compression may effect the cure of this disease either by obliterating the canal of the wounded artery, or by placing the opposite sides of the vein in contact with each other, and effecting their adhesion, so as to close the opening by which the artery communicated with the vein. Scarpa refers to two cases recorded by the Brambillas, in the first of which "the cure was undertaken four days after the accident by means of compression, by placing upon the tumour a ball of lint dipped in styptic water; over this graduated compresses; and a roller with many circles round the arm. In the course of six months, the most scrupulous attention being paid to the renewal of the bandage when it began to relax, the patient was radically cured. The other case was of a boy fourteen years of age, in whom the compression was employed a fortnight

after the appearance of the aneurismal varix. In the course of fourteen weeks of assiduous treatment this boy was cured, and there only remained at the place of the aneurismal varix a very small hardness about the size of a pea*." Guattani relates a similar case†; and Monteggia observed, during the cure of an aneurismal varix which was effected by compression, that a coagulum was formed in the tumour, which then became hard, lost its pulsation, and soon after disappeared‡. The possibility of producing an aneurism between the artery and the vein, by obstructing the flow of blood from the one into the other when the coats of the two vessels are not intimately united, appears to have deterred surgeons from attempting the cure of this disease by compression, and they have generally been satisfied with recommending the patient not to expose the limb to violent exertions.

In order that an aneurismal varix be formed, it is necessary that the vein be in immediate contact with the artery; and not only that the wound in the two vessels should communicate directly with each other, but also that the sides

* *Treatise on Aneurism*, WISHART'S *Translation*, p. 394.

† *De Externis Aneurismatibus*, p. 178.

‡ See SCARPA, *Treatise on Aneurism*, WISHART'S *Translation*, p. 395.

of these wounds be intimately united by the adhesive inflammation. If the vein be not in immediate contact with the artery, or if the blood meet with obstruction in its passage from the one into the other, in consequence of the obliquity of the wound, the employment of compression, or any other cause, the cellular membrane connecting the vein and artery may be dilated into an aneurismal sac, through which the two vessels will communicate with each other. In this case the vein will be removed to some distance from the artery, and the aneurismal sac will be situated between the two vessels: the blood will first pass from the artery into the aneurismal sac, and from the aneurismal sac into the dilated vein. This variety of the disease may with propriety be denominated varicose aneurism, to distinguish it from aneurismal varix.

If the opening by which the aneurismal sac communicates with the vein be not sufficiently large to allow the blood thrown into the former from the artery to pass readily into the vein, it is evident that the aneurismal sac will enlarge, and may require a surgical operation. It is probable that tying the artery above the tumour would effect the cure of this disease in the same manner as it does that of circumscribed aneurisms. The diminution of the force of the circulation after

the operation would promote the formation of coagulum, with which the sac would be filled, so as to close the opening by which it communicated with the vein. I am not, however, aware that this operation has been tried*. In the only cases of this disease hitherto recorded the sacs were opened, and both extremities of the artery were tied in that situation. The first of these cases is related by Mr. Park, of Liverpool †. The disease commenced about a week after the patient had been bled in the arm. Four months after the accident the tumour was as large as a walnut: it pulsated like an aneurism, and on pressure disappeared in a considerable degree, but not entirely. The hissing and peculiar thrilling sensation which characterize the aneurismal varix, were very plainly perceptible for a certain distance from the centre of the tumour towards the axilla. The basilic vein was considerably distended, but not to the degree which has generally been observed in aneurismal varix. The patient was advised to refrain from violently exerting the

* Scarpa recommends this operation if the aneurism be circumscribed; but if it be diffused, of course it must be treated in the same manner as diffused aneurisms in general. —See SCARPA, *Treatise on Aneurism*, WISHART'S *Translation*, p. 397.

† *Medical Facts and Observations*, vol. iv. p. 111.

injured arm, but in a few months it was observed that the tumour had rapidly increased. A year after the accident he came into the infirmary on account of a violent pain which he felt in the tumour, accompanied by inflammation and suppuration. The next morning the tumour burst, and only a small quantity of pus was discharged; but in a few days the blood burst forth with considerable force. The external sac or the aneurismal varix being laid open, and the coagulum removed, an orifice was discovered at the bottom of the cavity, similar to that which is usually made in venesection, from which arterial blood flowed on loosening the tourniquet. A probe introduced into this orifice sunk nearly an inch deep, but would not pass much more than half an inch upwards or downwards along the arm. This orifice being enlarged with the scissars, it was found that it led into a second sac below the first. Having removed the blood which filled it, the wound in the artery was discovered at the bottom of this second or lower sac, and a probe introduced into it passed readily upwards and downwards in the direction of the artery. Directed by this probe a ligature was placed underneath the artery above the wounded part, and tied. On loosening the tourniquet, as the blood flowed out as freely as before, the artery was tied below the wound, and then the hæmor-

rhage ceased. The patient regained the entire use of his arm. A similar case is related by Dr. Physick, of Philadelphia*, whose patient was cured by a similar operation.

* *Medical Museum*, vol. i. p. 65.

PART IV.

ON THE DISEASES OF VEINS.

SECTION I.

INFLAMMATION OF VEINS.

Veins are liable to all those morbid changes which are common to soft parts in general, but the membranous lining of these vessels is peculiarly susceptible of inflammation. When a vein is wounded, the inflammation which is the effect of the injury sometimes extends along the lining of the vessel into the principal venous trunks, and in some instances even to the membrane which lines the cavities of the heart. This inflammation sometimes produces an effusion of coagulating lymph, by which the opposite sides of the vein are united so as to obliterate the tube; in this manner a great extent of the vessel is occasionally converted into a solid cord. In some instances the secretion of pus into the

cavity of the vessel is the consequence of inflammation of the membranous lining of veins: under these circumstances the matter is either mixed with the circulating blood, or, the inflammation having produced adhesion of the sides of the vessel at certain intervals, boundaries are formed to the collections of pus, which in this manner form a chain of abscesses in the course of the vessel.

When the inflammation of veins is not very extensive, its symptoms are the same as those of local inflammation in general; but when the inflammation extends into the principal venous trunks, and pus is secreted into the vessel, it is accompanied with a high degree of constitutional irritation, and with symptoms which bear a striking resemblance to those of typhus fever. I have selected the following case from several, because it exhibits not only the symptoms, but also the appearances on dissection. It was communicated to me by Mr. Broughton, Surgeon to the Life Guards.

CASE XLIX.

A ROBUST soldier, thirty-six years of age, was bled in the arm for ophthalmia, which was considerably relieved by the operation. A degree of fever, however, came on, and gradually increased. On the seventeenth day after the bleeding his pulse was one hundred and twenty in a minute, and feeble:

his skin was hot: his tongue was covered with brown fur: his respiration was difficult: he complained of great prostration of strength, and pain in his head, back, and extremities. The wound in the vein had healed, but, the day after the bleeding, great swelling and pain commenced in the arm, and gradually extended upwards. He was bled in the opposite arm, and various medicines were administered. The symptoms continued, with very little alteration, until the twenty-third day, when a painful swelling was observed above the clavicle, and, in a few days afterwards, another soft diffused swelling was discovered underneath the angle of the lower jaw. The symptoms increased slowly. Respiration became more painful and difficult: the pulse was seldom less than one hundred and twenty: he became delirious, and died in the course of the seventh week after the bleeding. The following appearances were observed upon dissection. The cephalic vein, at the part where it had been punctured in the first instance, resembled an artery in the thickness of its coats, and in retaining a circular form when cut across. Below the punctured part it was healthy. About an inch above the puncture its cavity was obliterated: the obliteration extended to the shoulder. The branches which communicated with the cephalic vein at the bend of the arm

were healthy. The absorbent glands above the clavicle were enlarged and hardened. The external jugular vein was less in size than the corresponding vein on the opposite side. The internal jugular vein was much enlarged, thickened, and indurated: the effects of inflammation were apparent throughout its whole course: it had the external appearances of an artery, though larger than any artery except the aorta. The subclavian, axillary, and brachial veins, to the bend of the arm, exhibited similar appearances. The external jugular and the subclavian veins were filled with pus. When slit open they were found to be much thickened, and lined with lymph. Many of the smaller veins were in a similar condition. There was so much inflammation, adhesion, and induration in the upper part of the arm, that it was extremely difficult to trace the vessels and detach them from their connexions. The vena cava superior was healthy. The diseased appearances were not gradually lost, but terminated abruptly. The heart was healthy. The lungs contained some small abscesses. A serous fluid, with flakes of lymph floating in it, was contained in the cavities of the thorax. The lungs adhered to the pleura costalis, partially on the left side, but more extensively on the right. The structure of the brain was natural, but more serum than is usual was

found in the ventricles : the veins of the pia mater were turgid with blood. The vena magna Galeni and the sinuses were remarkably loaded.

Several cases of extensive inflammation of veins after the operation of venesection have been communicated to me, and I have seen one in which the symptoms and appearances upon dissection, although not so extensive, were similar to those which are described in the preceding case. The symptoms were very like those of typhus fever, and the appearances upon dissection were in some places adhesion and obliteration of the vessels, in others effusions of coagulated lymph or pus* into their cavities, with great induration, thickening, and adhesion of the surrounding parts. In some instances the inflammation has extended downwards as well as upwards in the course of the vein†. The same symptoms have taken

* Instances have occurred in which a fluid resembling pus was found in the veins, although it does not appear to have been the consequence of inflammation. Bichat examined a body in which he found the splenic vein, as well as the trunk of the vena portæ, and all its hepatic branches, filled with gray coloured matter (sanie grisâtre). — *Anatomie Générale*, tome i. — *Considérations Générales*, p. lxx.

† See Hunter, in *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 18. — Abernethy, *Surgical Observations, on the occasional ill Consequences of Venesection*, p. 147. Second edition.

place when inflammation of a vein has been excited by the application of a ligature; and Mr. Hunter observed similar appearances in the bodies of those who died after amputations, compound fractures, and mortifications *. In several cases of puerperal fever, Dr. Clarke † found the veins of the uterus filled with pus. In the dissection of a woman who died four or five weeks after delivery, Mr. Wilson found the coats of the principal veins of the uterus thickened, and partially obliterated. The common, the external, the internal iliac veins, with most of their larger branches, particularly those which returned the blood from the uterus, as well as the emulgent and spermatic veins, exhibited the effects of inflammation. Their coats were thickened, and their cavities obliterated, by lymph or plugs of coagulum. The coats of the vena cava inferior were at least three times thicker than natural, and adhered very firmly to the surrounding parts. This vessel contained about four ounces of well-formed pus, which had been prevented from passing to the heart, partly by a contraction or puckering of the vessel immediately below the

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 19.

† *Practical Essays on the Management of Pregnancy*, &c. p. 63, 72. Second edition.

entrance of the three large venæ cavæ hepaticæ, and partly by a quantity of coagulable lymph, which adhered to its coats, and plugged up the cavity of the vessel to the extent of about a quarter of an inch. A quantity of coagulable lymph, intimately adhering to the inside of the vein, had completely filled up its cavity from the emulgent veins downwards *.

When the inflammation is confined to the punctured vein, its treatment should be the same as that of local inflammation in general; namely, the application of leeches, the use of evaporating washes, purgatives, and low diet. Mr. Hunter conceived, that if compression were applied to the inflamed vein above the wounded part, so as to place the opposite sides of the vessel in contact and cause them to adhere, the inflammation would be prevented from extending along the continuous surface of the membrane lining the tube. In

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. iii. p. 65. In addition to this case, Mr. Wilson met with the same appearances in the bodies of two women who died a few days after parturition. "In both of these, some of the larger veins of the uterus contained pus, and in both the obliteration of part of the vena cava inferior, by coagulable lymph strongly adhering to its inner surface, and filling up its cavity, had taken place. — Ibid. p. 80.

one case Mr. Hunter tried this practice, and, as he supposed, with success*. The constitutional irritation which takes place in extensive inflammation of veins, is attended with symptoms of greater debility than acute inflammation in general. This circumstance may probably arise from the extent of the inflamed surface, but it is not improbable that it may be an effect produced upon the nervous system by the pus which is secreted into the vessel being mixed with the circulating blood. Although the symptoms appear to afford opposite indications, it is evident that such extensive inflammation as was going on in the cases which I have mentioned in the commencement of this Section, could only be controlled, even in its early stage, by copious bleedings, and a rigid employment of all those means which tend to subdue acute inflammation in general.

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 29.

SECTION II.

OF VARIOUS MORBID APPEARANCES IN THE COATS OF VEINS.

Inflammation frequently produces thickening of the coats of the veins, as well as adhesion of their sides, and obliteration of their cavities. Ulceration sometimes extends to the coats of veins, and by exposing their cavities gives rise to hæmorrhage. In some instances ulceration commences in the membranous lining of veins, and destroys the coats of the vessel. In the body of a woman Portal found the coats of the vena cava superior in some places thicker, in others thinner, than natural, and apparently ulcerated upon their internal surface. Immediately above the right auricle an opening was discovered in the coats of this vessel, through which the blood had escaped into the pericardium *. In general, however, the adhesive inflammation precedes the ulcerative, and by obliterating the cavities of these vessels prevents the occurrence of hæmorrhage. When sphacelation takes place in the vicinity of veins, their cavities, like those of arteries under similar circumstances, are filled with extensive plugs of coagulum, which pre-

* *Anatomie Médicale*, tom. iii. p. 354. Morgagni relates a case in which the internal surface of the extremity of the vena cava superior appeared eroded. — Letter liii. art. 37.

vent hæmorrhage upon the separation of the mortified part.

Veins are sometimes ruptured without any morbid alteration having existed in their structures. Their rupture, under these circumstances, may be the consequence of violent muscular exertions, or accidental violence: in some instances it has appeared to arise from sudden and excessive accumulation of blood. I have seen two cases in which a vein on the calf of the leg was ruptured during violent attacks of cramp in the gastrocnemius muscle. Accumulations of blood underneath the skin were the consequence. Portal examined the body of a young woman who died suddenly in a cold bath. The vena cava superior was ruptured immediately above the right auricle, and a great quantity of blood had escaped into the right side of the chest*. Senac has related cases in which veins were ruptured during the cold stage of intermittent fevers †. The valves of veins are sometimes ruptured, and the pressure of the column of blood causes the vessel to become varicose.

Although a deposition of calcareous matter almost invariably takes place in the arteries of persons advanced in life, it is an extremely rare occurrence in the coats of veins ‡. Dr. Baillie

* *Anatomie Médicale*, tom. iii. p. 355. † See ibid.

‡ This circumstance induced Bichat to conceive that there

mentions an instance " where a considerable ossification was found in the coats of the vena cava inferior, near its bifurcation into the two iliacs*." Dr. Macartney informs me that he met with several depositions of calcareous matter in the external saphena vein, in a man who died of a diseased liver. There was an ulcer on the leg, but the depositions of calcareous matter appeared to have no immediate connexion with the ulcer. One of the depositions was nearly an inch in length, and was situated on the internal surface of the vessel. Loose calculi have been found in

was a difference in the organization of the membranous lining of veins and arteries. — " Jamais cette membrane commune ne s'ossifie chez le vieillard, comme il arrive dans les artères : son organisation parôit répugner à se pénétrer ainsi de phosphate calcaire. Quand cela arrive, c'est un état contre nature ; au lieu que l'ossification de la membrane commune du sang rouge est un état presque naturel chez le vieillard." *Anatomie Générale*, tome ii. p. 404.

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 134. Morgagni has given a brief account of a case in which the coats of the vena cava were " in great measure cartilaginous, and even in some measure bony." — *Letter* lxiv. art. ix. Ploucquet refers to the following works, under the heads " Ossificatio " and " Calculus in Venis." *Ephem. Nat. Cur.* dec. 1. ann. iii. obs. 307. (*in mesaraicis.*) — Walter, *Observat. anat.* p. 41, 45. — Murray, in *Act. Med. Succic.* i. p. 3. — Walter, *Anat. Mus.* i. p. 172. — Marcellus Donatus, l. iv. c. 30. p. 521. (*in Vena Portarum*).

the cavities of veins. Mr. Langstaff recently met with three calculi as large as small peas in the veins of an uterus. Similar concretions are sometimes found in dilated veins surrounding enlarged prostate glands. In such cases it is not improbable that the calculi are formed in the surrounding parts, and make their way into the veins by progressive absorption*.

* Ploucquet has given the following reference under the head "Vena.—Ossificatio." "Tilorier in *Bulletin de la Société de Médecine*, p. 224. *app. ad Journal de Médecine continué*, vol. xi. *(Concretiones globulosæ fere liberæ in iis.)*" Mr. Cooke, of Plaistow, has communicated to me a case which probably may be regarded as illustrating the possibility of a foreign body passing into the cavity of a blood vessel in consequence either of ulceration, or of that peculiar process which Mr. Hunter has denominated progressive absorption.

"On the 9th of September, 1811, a gardener, whilst endeavouring to secure the lock of a spring gun which he was accustomed to set in his premises, struck the wire connected to the trigger with his right foot. The whole charge was lodged in the inner part of the calf of his left leg, which happened to be placed against the muzzle of the gun. The wound was circumscribed, and passed in a direction towards the opposite side of the limb, almost close to the tibia. None of the shots had passed through the limb, nor could they, or the bottom of the wound, be felt by introducing a finger. No hæmorrhage took place. The limb was kept quiet; and as it was probable from the direction of the wound that bleeding might take place when the sloughs were detached, a precautionary tourniquet was kept

Veins, as well as arteries, are sometimes involved in morbid growths which exist in their vicinity. In these cases the coats of the vessels assume the appearance of the contiguous morbid structure. In some instances the disease commences in the membranous lining of the vein, without having extended to it from the surrounding parts. In examining the body of a man who died of what is commonly termed schirrous pylo-

upon the thigh, but not in such a state as to make the least pressure upon the artery. Inflammation, suppuration, and sloughing ensued, but merely a few drops of blood were discharged upon the separation of the sloughs. About three weeks after the accident some of the shots were felt on the opposite side of the limb. They were extracted by dividing the skin. At this time the original wound was greatly contracted, but a probe could be passed through the limb with facility. The wound on the outside of the leg healed, and the patient was able to move the gastrocnemius and soleus muscles more freely; but as it was probable that the cure would be tedious, he went into a hospital. Here also the condition of the limb continued to improve until the 25th of February, 1812. When he awoke on that day the bed was wet, and he felt faint. The small wound in the leg was bleeding profusely, and the blood had already soaked through the bed. The limb was amputated; and, when dissected, about eighty shots were discovered in it. One shot was found in the posterior tibial artery, from which vessel the bleeding had proceeded. Under all the circumstances of the case, it appears very improbable that this shot had remained in the artery from the time of the accident.

rus, I found that extremity of the stomach which is connected to the duodenum surrounded with a large tumour. This tumour had a pulpy feel, and when cut into had a medullary appearance. Several contiguous absorbent glands were converted into a similar structure. The splenic vein was dilated, and, upon slitting it open, I found a tumour, larger than a hazel nut, growing from the membranous lining of the vessel. This tumour resembled in its appearance and consistence the disease which existed at the pylorus and in the absorbent glands. It was, however, situated at some distance from those parts, and the cellular membrane surrounding this portion of the vein was healthy in its appearance. Cases will be related in the following Section in which veins were obliterated in consequence of being involved in medullary growths which extended to them from contiguous parts.

SECTION III.

OF THE OBLITERATION OF VEINS AND VENOUS COLLATERAL CIRCULATION.

A FREQUENT cause of the obliteration of the cavity of a vein is the adhesion of its sides in consequence of inflammation of its lining membrane. The inflammation is sometimes of an acute form, as in the cases which I have mentioned in a preceding Section*: sometimes it is more limited in its extent, and slow in its progress, as in those instances in which the cavities of veins are obliterated by the pressure of neighbouring tumours. In some instances also veins are involved in morbid growths, by which their cavities are obliterated. In general a plug of coagulated blood is found in the vessel for a considerable extent below the part which is in the first instance obliterated. This coagulum is absorbed, and the coats of the vein are ultimately converted into a ligamentous band.

The venous, like the arterial system, appears to be capable of carrying on a collateral circulation when any part of it is impervious. The effects which might be expected to follow the obliteration

* See page 511.

of a principal vein are obviated by the number of its communicating branches, which, in their natural state, are so arranged as to afford a ready passage for the blood into the superior venous trunks when an inferior portion of the vessel is impervious. It appears to be through the innumerable communications of the superficial branches that the circulation is carried on when a principal vein is obliterated, although a few channels are ultimately more dilated than the rest.

Many cases have occurred in which not only its principal branches, but even the vena cava inferior has been obliterated, and the blood was conveyed through collateral channels to the heart. Dr. Baillie* mentions an instance in which the vena cava inferior of a female subject, which was brought for dissection, "was found to be changed into a ligamentous substance, from the entrance of the emulgent veins even to the right auricle of the heart. The cavity here was so entirely obliterated, as not only to prevent all circulation of blood through this part of the vein, but even in a great measure to prevent the admission of

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. i. p. 127. plate v. Bartholini mentions a case in which the vena cava inferior was obliterated near the heart, but he relates no particulars of it.—*Obs. Anat.* cent. II. hist. XXXV.

air by inflation. The blood being prevented from passing through the vena cava inferior, flowed into the lumbar veins, enlarging them gradually as that vein became contracted, till at length they were of a sufficient size to receive the whole blood which returns by the vena cava. From the communication between the lumbar veins and the vena azygos, the blood passed into this vein and was conveyed to the heart. It happened in this particular instance that there was an additional vena azygos upon the left side of the spine, so that the blood was conveyed more readily to the heart than if there had been one vena azygos as in ordinary cases. The enlarged veins were in some places thrown into varices." In this remarkable case the vena cava inferior was obliterated where the venæ cavæ hepaticæ opened into it, so that not only the blood from the lower extremities, but also that from the liver must have passed through collateral channels to the heart*.

Several cases are recorded in which the cavity of the vena cava was obliterated between the part

* In chronic diseases of the liver the branches of the veins are sometimes filled with plugs of coagulum. This fact was first pointed out to me by Dr. Farre, and I have since had several opportunities of observing it. I have also found the branches of the pulmonary veins filled with coagulum in cases of extensive tubercular disease in the lungs.

where the venæ cavæ hepaticæ and the common iliac veins open into it. In a former section* I have mentioned a case in which Mr. Wilson found not only the whole extent of the vena cava below the entrance of the hepatic veins, but also the emulgent, spermatic, primary, external and internal iliac veins, and their larger branches, filled with lymph and firm plugs of coagulated blood. The vessels of the lower extremities were in a natural state: no undue accumulation of blood had taken place in the veins, nor had any watery fluid collected in the cellular membrane. "The anastomosing branches of the veins on the sides and back part of the pelvis were much enlarged, as were also those between the vena saphena major, and the branches accompanying the deep-seated arteries passing through the foramen magnum ischii and the sciatic notch. Large communications were seen filled with fluid blood between the venæ pudicæ externæ, and the lower branches of the vena mesenterica inferior, which was enlarged to treble its natural size. The veins coming from the sinuses of the dura mater in the theca vertebralis, the sinuses themselves, and the veins entering them, were much enlarged; and the communications between them and the sacral and

* See page 516.

lumbar veins were, by the blood contained in them, rendered very apparent. The enlarged branches of the lumbar veins formed such easy communications with each other, as to allow a passage through them to a very large quantity of blood, which entered the vena azygos by the anastomosing branches of its lower part. This vein, although three times larger than it commonly is, was without the varicose appearance described by Dr. Baillie. The emulgent and phrenic veins communicated largely with the lumbar veins and the vena azygos. The blood passed from the venæ pudicæ externæ into the inferior mesenteric veins, and from thence to the venæ portæ; it circulated afterwards through the liver, and entered the lower part of the right auricle of the heart, by the very small portion of the vena cava inferior which remained pervious, viz. between the auricle and venæ cavæ hepaticæ. The remaining part, having reached the vena azygos, passed from it into the vena cava superior, and entered the same auricle from above*." Mr. Cline found the inferior vena cava obliterated a little above its bifurcation, in consequence of the formation of a steatomatous tumour in the cellular membrane behind the peritoneum. The tumour occupied a part of the pelvis and loins.

* *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. iii. p. 70.

"The epigastric veins were become as large as the little finger, and the superficial veins of the abdomen, as well as the lumbar, and those of the internal cavity of the abdomen, were in a similar manner very much dilated: the internal mammary vein likewise greatly enlarged, and also the epigastric with which it anastomosed, opened as usual into the superior cava, near to the origin of the subclavian veins; by which circumstance the venous blood of the lower extremities was poured into the superior cava, by means of the mammary vein, and into the inferior cava by the lumbar veins, above the compression caused by the steatomatous tumour*." A case in which the vena cava was obliterated between the emulgent and iliac veins is also mentioned by Haller†.

I have seen two instances in which the common iliac vein was obliterated. One of these cases occurred in a woman whose uterus was converted into a medullary tumour, which filled the pelvis,

* See SCARPA, *Treatise on Aneurism*, WISHART's *Translation*, p. 20. note.

† "Ea in femina non multo quadragenaria majori inter renales venas et iliacas concreta fuit, ut nihil cavitatis loco superesset, nisi fibrosa quædam, quasi carnea, polyposa et dura caro. Sanguinem autem ab aorta inferiori reducebat vena spermatica dextra, enormiter se ipsa sana latior, unciali diametro, quæ sanginem immittebat venæ perinde dilatatæ uretericæ dextræ, ab iliaca ejus lateris ortæ." — *Opuscula Pathologica*, Obs. XX.

and projected into the abdomen. The sigmoid flexure of the colon, the rectum, bladder, ureters, ovaries, fallopian tubes, and vagina, were enveloped in the pulpy mass, which also extended to the blood vessels, and had caused the obliteration of the left internal iliac artery, and the common, external, and internal iliac veins on both sides of the body. The coats of these veins were in some places completely destroyed, so that it was impossible to trace them. As the parts were removed before the condition of these vessels was examined, I was not able to make any observations as to the mode in which the circulation had been carried on. In the other case, in which the common, the external, and internal iliac veins on the left side were obliterated by the pressure of an aneurism of the abdominal aorta, the vena azygos was as large as the little finger, and extended on the left side into the loins, where it received two considerable branches, which communicated with the lumbar veins, and with branches which came from the pelvis. In both these cases there were no symptoms which indicated obstruction in the venous circulation during the life of the patients. Morgagni* found the cavity of the iliac vein obliterated by the adhesion of its sides, and the femoral vein contracted and filled with

* Letter lvi. art. 10.

a bloody concretion. The limb was œdematous, and the head of the os femoris had been destroyed by disease. A case has been related to me in which œdema of the limb attended the obliteration of the femoral vein; but the facts which I have mentioned prove that dropsical effusions are not in general the consequence of the obliteration of a principal vein. I have seen several preparations in which the femoral vein was obliterated, and have known an instance in which it was included in a ligature without any unfavourable consequences.

Dr. Hunter has recorded a case in which the vena cava superior and the common trunk of the left subclavian and jugular veins were so much compressed by an aneurism of the aorta, "as hardly to have any thing left of their natural capacity and appearance*:" but I am not aware that the vena cava superior has in any instance been found completely obliterated. It is probable, however, that were this vessel impervious, the blood from the upper parts of the body would pass into the inferior vena cava by the intervention of the branches of the vena azygos. Thus the blood from branches of the axillary and subclavian veins, would pass into branches of the vena azygos, and be transmitted through

* *Medical Observations and Inquiries*, vol. i. p. 333. Third edit.

other branches of this vessel into the lumbar, diaphragmatic, emulgent, and spermatic veins, which open into the vena cava inferior. The mammary would also transmit a considerable stream into the epigastric veins. If one of the subclavian veins were obliterated, the communications between its branches and those of the corresponding vein on the opposite side of the body, as well as with the vena azygos, would afford a passage for the blood into the superior vena cava.

Cases have been recorded in which the internal jugular vein was obliterated. In the following instance the obliteration of this vessel was the consequence of the extension of morbid structures to its coats. I am indebted to Mr. George Young for the notes of this case, and for an opportunity of examining the parts.

CASE L.

A SAILOR, about fifty years of age, had an ulcer in the fauces, which communicated with a chain of tumours surrounding the larynx and pharynx, and affording great impediments to respiration and deglutition. The tumours increased during several months, when the patient died, worn out by the irritation and pain which they excited. When dissected, these tumours were found to consist of a soft medullary matter con-

tained in a cellular structure. One of the tumours projected into the fauces, and had excited ulceration, which extended to the epiglottis. The carotid artery and the internal jugular vein were enveloped in these morbid growths. The cavity of the artery was of its natural size, and its coats were healthy. The left internal jugular vein, for the extent of two inches where it passed through the tumours, was completely obliterated. The sides of its extremities had adhered, and the texture of its coats, in the intervening space, was lost in the diseased mass. The opposite vein and artery were healthy: no other morbid appearance was discovered in the body.

A similar case has recently been published by Mr. Lardner of Birmingham*. Mr. Lardner showed me the morbid parts which were taken from his patient. The structure of the tumour and the condition of the vein were precisely similar to those which I have described in the preceding case. In the Edinburgh Medical Essays† a case

* *Edinburgh Medical and Surgical Journal*, vol. vii. p. 407.

† Vol. v. p. 337. Fifth edition. This case is related by Dr. Thomas Simpson, Professor of Medicine in the University of St. Andrews. The remarkable circumstances with which it was attended induce me to insert the following account of the operation. "In dissecting out this tumour I laid the carotid artery bare for about two inches, and plainly saw its pulsation. From the upper part of the

is related in which the internal jugular vein was involved in a tumour, so that its cavity was obliterated. The tumour was extirpated, and during the operation the upper part of the vein was tied. Mr. Simmons of Manchester has also published a case in which he tied the internal jugular vein. In this case a large tumour on the left side of the neck extended from the outer margin of the sterno-cleido-mastoideus muscle nearly to the shoulder. The tumour was extirpated. "The divided arteries bled freely, but the blood rushed in a torrent from the internal jugular vein, which had been divided in the operation."

tumour a cartilaginous process went to the larynx, to which it was strongly attached. In cutting this away, there was a strong jet of blood from an artery, which soon stopped after the application of spirit of wine to it; so that I went on with the dissection of the tumour from the vein downwards. After laying the vein bare a considerable way, I found it confounded at the lower part with the substance of the tumour; and therefore putting a ligature round the vein, I tied it, and then cut away the remaining part of the tumour below, except a small part, in which I thought the vein was involved, expecting the ligature would make this fall off: but seeing no appearance of such a separation after eight days, I cut it through immediately below the ligature, and found the vein and all quite solid, of a cartilaginous firmness. After this hard substance was all taken away, the large cavity, where the tumour had been lodged, filled up very fast; so that the wound was cicatrized in six weeks."

This vein was tied with three ligatures, which came away in due time without hæmorrhage, and the parts healed in about two months. In this case it was remarked that no morbid affection of the head was the consequence of the obliteration of the internal jugular vein*. Haller found the cavity of the common carotid artery obliterated by a plug of coagulum, of a white colour, and adhering intimately to the internal coat of the vessel: the internal jugular vein was also filled with a similar substance, which extended to the part where a communicating branch from the external jugular opened into the internal, underneath the parotid gland. The lower part of this substance was inseparably connected with the coats of the vessel †.

* *Medical Facts and Observations*, vol. viii. p. 23.

† *Opuscula Pathologica.* Obs. xix. tab. 1. See also page 314 of this Treatise.

SECTION IV.

ON VARICOSE VEINS.

When the circulation through a vein is obstructed, the inferior portion of the vessel and the branches opening into it are dilated by the accumulation of blood in their cavities. If the obstruction continue, the dilatation of the veins becomes permanent, and their valves being incapable of supporting the blood, the disease is increased by the pressure of the column in the upper part of the dilated vessel. In some instances it is probable that the valves are ruptured in consequence of muscular exertions, or external violence, in which cases the pressure of the column of blood is the first cause of the dilatation of the veins. Sometimes also the disease appears to arise from præternatural weakness in the coats of veins, as in those instances in which, without any evident cause, it exists in various parts of the same person. When a vein is obliterated, the anastomosing channels through which the circulation is carried on generally become varicose, in consequence of the unusual influx of blood into their cavities. This fact was remarked by Dr. Baillie in a case of obliterated vena cava; and several observations, which will be mentioned hereafter, afford it additional confirmation.

When a vein is dilated, it generally increases in length, so that it cannot be contained in the space which it occupied in its natural state. In consequence of this circumstance, a dilated vein assumes a serpentine course; and, when the surrounding parts are of a loose texture, its convolutions are sometimes coiled upon each other like the folds of an intestine, and form a varicose tumour. A small portion of a vein is occasionally more dilated than the rest, and forms a prominent tumour, which is denominated a varix. The coats of the vein, as their dilatation increases, become thickened and attached to the surrounding parts, and a serious hæmorrhage is occasionally the consequence of the rupture of the dilated vessel.

The great venous trunks sometimes become varicose: when the disease is situated near the heart, it is attended with pulsation, which renders it liable to be mistaken for aneurism. Morgagni observed that the jugular veins were occasionally very much dilated, and possessed a pulsation*. He also relates a case in which the vena azygos, for the length of a span, was so much dilated that it might be compared with the vena cava. The patient died suddenly, in consequence of the rupture of this varix into the right side of the chest†. A similar case is related by Portal, who

* Letter xviii. art. 9, 10, 11. † Letter xxvi. art. 29.

also mentions an instance in which the right subclavian vein was excessively dilated, and burst into the chest*. Mr. Cline described in his lectures the case of a woman who had a large pulsating tumour in her neck, which burst, and proved fatal by hæmorrhage. A sac proceeded from the internal jugular vein: the carotid artery was lodged in a groove at the posterior part of this sac. The veins of the upper extremity very rarely become varicose. Excepting cases of aneurismal varix, the only instance of this disease in the arm, with which I am acquainted, is mentioned by Petit†. In this case a varix was situated at the bend of the arm: the patient was so fat that no other vein could be found for the purpose of venesection, which operation Petit repeatedly performed by puncturing this varix. The superficial epigastric veins sometimes become varicose, but the most frequent seats of this disease are the venæ saphenæ, the spermatic, and the hæmorhoidal veins.

The gravid uterus, tumours in the lower part of the abdomen or pelvis, and collections of fæces in the intestines, by obstructing the return of blood through the iliac veins, are frequent causes of varicose enlargements of the superficial veins of the lower extremities. Great and continued muscular

* *Cours d'Anatomie Médicale*, tom. iii. p. 354, 373.

† *Traité des Maladies Chirurgicales*, tom. ii. p. 49.

exertions of the lower extremities, the use of tight garters, and the pressure of tumours, produce the same effects. The dilatation is generally confined to the superficial veins*, and in most instances commences near the ankle. In some cases the dilatation occupies not only the trunks, but also the minute cutaneous ramifications of the veins: sometimes the enlargement is confined to the trunk, which is not only dilated throughout its whole extent, but in some places is expanded into tumours of a blue colour, varying in dimensions from the size of a small nut to that of a pigeon's egg. When a varicose vein is in contact with a bone, the latter is sometimes absorbed, so as to form a groove in which the vessel is lodged. The dilatation of the veins is frequently attended with excruciating pain, and sometimes with inflammation of the skin and cellular membrane. This inflammation occasionally terminates in the formation of abscesses round the vein: in other instances it is of a more chronic nature, and produces indolent ulcers. These ulcers are generally

* The deep-seated veins of the extremities rarely become varicose. The femoral vein immediately below Poupart's ligament is sometimes dilated into a tumour, which is liable to be mistaken for femoral hernia. It may, however, be distinguished from hernia by compressing the vein below the swelling, in which case, if it be formed by a varicose enlargement of the femoral vein, the tumour diminishes.

situated near the ankle, and are remarkably intractable. They appear to depend upon the varicose condition of the veins, for when the latter is relieved, the ulcers are as readily cured as ulcers in general.

The blood occasionally deposits strings of coagulum in varicose veins: when this is the case, the vessel is incapable of being emptied by pressure, and is firm to the touch. The deposition does not in general fill the vessel, but, by diminishing its calibre, it retards the flow of blood, and causes the dilatation to increase in the inferior portion of the vein, and in the branches which open into it. Petit, who had observed this circumstance, was accustomed to open varicose veins and draw out the string of coagulum*. By removing this cause of obstruction, not only the increase of the disease was prevented, but the dilated vessels frequently diminished after the operation. Sometimes, however, the coagulum accumulates to such an extent, as completely to obliterate the canal of the dilated vessel. I have seen four cases in which this event terminated in a spontaneous cure of varices. In these instances it is probable that the coagulum accumulated until it completely filled the varix, or the upper portion of the vein communicating with it; the blood,

* *Traité des Maladies Chirurgicales*, tom. ii. p. 41, 63.

being unable to pass forwards, coagulated in the vessel to a considerable extent; this coagulum was gradually absorbed; as its absorption advanced, the coats of the vein contracted; the vessel was ultimately obliterated, and the blood was conveyed through collateral channels.

CASE LI.

A MAN, nineteen years of age, by trade a carpenter, in the year 1806 perceived the veins of his right to be larger than those of his left leg. From this time they gradually increased, and in January, 1814, there was a cluster of enlarged veins on the inside of the calf of the leg near the middle of the tibia: in the course of the vena saphena major, a little below the knee, there was a varix as large as a pigeon's egg; and, in the middle of the thigh, there was another varix of equal dimensions. The intermediate portions of the vein were dilated, and when he was in a recumbent posture, the swellings had hitherto disappeared. But a few days after exercising the limb for several hours more violently than usual, he observed that the swellings could not be emptied by pressure, nor did they disappear when the limb was elevated. It was evident that the circulation through them had ceased: they became hard and very painful: the vein between the tumours felt like a cord under the skin. When I

saw him, the vena saphena major, from the middle of the leg to the middle of the thigh, was in this condition. The tumours, though hard in their circumferences, were elastic in their centres: the skin which covered them was of a dull red colour: he complained of great pain in the limb, and more particularly at the ankle. A cold lotion was applied to the tumours: he was directed to keep the limb in a horizontal posture, and at perfect rest. Under this treatment the pain abated: in a few days the tumours were covered with soap plasters, and the limb was rolled from the toes to the groin. The tumours gradually decreased: five months after the time when the circulation through the vein was first observed to have ceased, the skin which covered them was level with the surrounding parts: the swellings were converted into small hard knots of the size of peas in the course of the vein, which felt like a solid cord. But while these changes were taking place, the veins round the ankle, and the vena saphena minor, were enlarged; and a short time afterwards, when the patient had returned to his trade, these vessels were evidently becoming varicose. Regular compression, by means of adhesives traps and rollers, has hitherto prevented the increase of their dilatation. Ten months have now elapsed since I first saw this patient: all that remain of the varix in the thigh and the one immediately below the

knee are two hard knots of the size of barley-corns. A vein, evidently pervious, and containing blood, is to be felt on the inside of the knee, in the situation of the vena saphena major; but it is doubtful whether it is that vessel, or a dilated collateral branch. It is probable that it is a dilated collateral branch, for a portion of the vena saphena major, on both sides of the inferior varix, is still hard, contracted, and evidently impervious: there can be no doubt that those portions of the vessel in which the varices were situated are obliterated. Numerous dilated veins from the ankle and the inside of the leg open into the vena saphena minor, a large tortuous branch of which extends across the ham.

CASE LII.

A WOMAN, about forty years of age, had for sixteen years been troubled with a varicose condition of the veins of the left leg, near the ankle of which an intractable ulcer was situated. There was also a large varix in the course of the vena saphena major a little below the middle of the thigh. Without any evident cause, the varix in the thigh suddenly enlarged, and was extremely painful: in a few hours it became hard, and when I saw it three weeks after these occurrences commenced, the skin covering it was of a dull red colour. A cold lotion was applied to the swelling, until the pain and

inflammation subsided: the limb was then surrounded with a common roller, moistened with vinegar and water, and the pressure was increased by degrees. The tumour gradually diminished, and was ultimately reduced to a very small hard knot, which possessed none of the characters of a varix.

It is not improbable that the cure of varices is sometimes the consequence of the inflammation and adhesion of the opposite sides of the dilated vessel; but in the cases which I have related the hardness and gradual contraction of the tumours appear to have been the consequences of the coagulation and subsequent absorption of the blood which they contained. In some respects, therefore, this process is similar to that by which the spontaneous cure of aneurisms is occasionally effected *.

* The following observations by Petit illustrate this subject. " Si-tôt que le tronc des vaisseaux est entièrement bouché par le premier caillot, le sang qui remonte par les branches se coagule à mesure qu'il arrive, la tumeur augmente et devient plus dure; elle n'est pas encore bien douloureuse, si ce n'est quand on la presse; elle n'obéit presque point au toucher, dans les premiers jours, mais peu-à-peu elle devient molle à sa circonférence, et au travers de cette mollesse on sent encore le caillot, plus petit, à la vérité, mais plus dur qu'il n'etoit, parce que la sérosité s'en est séparée: c'est cette sérosité qui fait la mollesse; elle entoure le caillot, et toujours renfermée avec lui dans la cavité du vaisseau, on apperçoit, au toucher, une fluctuation qui en imposeroit à ceux qui ne seroient pas instruits de cette circonstance.

Various modes of treating varicose veins have been recommended, either for the purposes of accomplishing a radical cure of the disease, or of palliating its progress and effects. The ancients removed varices by excision, or destroyed them with burning irons. Celsus*, whose practice in this disease is quoted by many subsequent writers, employed both the actual cautery and excision. When the vein was much convoluted, he preferred its extirpation; but when it was strait, he exposed it by dividing the skin, and applied the cautery to different portions of the dilated vessel. Although there can be no doubt that these operations were frequently performed in the days of Celsus, who delivers it as an axiom that every diseased vein should be destroyed either by the cautery or excision†, yet the inconvenience occasioned by the disease is rarely sufficient to justify the employment of such

J'en ai vues que l'on avoit ouvertes, croyant ouvrir un abcès. Quoique ce soit une erreur, ce n'est pas toujours un mal, parce que la sérosité sanguinolente qui en sort, quoiqu'en médiocre quantité, débarrasse et soulage d'autant la partie; de plus, si le caillot se présente à l'ouverture que l'on a faite, et si cette ouverture est assez grande pour qu'on puisse le tirer, il peut arriver qu'on débouche le tronc de la veine variqueuse, et même l'embouchure de plusieurs vaisseaux qui s'y viennent décharger; ce qui opere un soulagement considérable."— PETIT, *Traité des Maladies Chirurgicales*, tom. ii. p. 42.

* *De re medicâ*, lib. vii. cap. xxxi. † Ibid.

painful remedies. In modern times, however, clusters of varicose veins have been successfully extirpated. Petit * recommended extirpation when only a portion of a vein was dilated and convoluted into a circumscribed tumour, in which the blood stagnated, and caused pain and inflammation. Boyer † relates a case in which he extirpated a tumour consisting of three or four large varices, situated on the outside of the leg. The veins were tied during the operation, and the patient recovered without any unfavourable consequences. It has generally been recommended, that, during the operation, the vein should be tied both above and below the varix before the latter is removed; but this point is not indispensable, for, in most situations, it will be possible to restrain the hæmorrhage by graduated compresses, adhesive straps, and bandages.

Another mode of effecting the radical cure of varices consists in cutting open the dilated vessel, removing the coagulum which it contains, and placing the opposite sides of the cavity in contact by means of compresses and bandages, which at the same time restrain the hæmorrhage. In this manner the adhesion of the opposite sides of the dilated vessel is effected, and its cavity is consequently obliterated. This practice, which, with

* *Traité des Maladies Chirurgicales*, tom. ii. p. 64.

† *Traité des Maladies Chirurgicales*, tom. ii. p. 254.

some modifications, appears to have been employed by Fabricius ab Aquapendente*, has been tried in this country. I am informed, that in several cases it succeeded in effecting the cure of varices in the leg; but, in some of these instances, it was followed by such violent symptoms of constitutional irritation, that its employment was discontinued.

Petit strongly insists upon the efficacy of puncturing varices and drawing off large quantities of blood, although he appears to have employed this practice merely as a palliative remedy in conjunction with others†. He was accustomed to choose one of the most prominent varices in the upper part of the limb, which he punctured with a lancet. During the bleeding, the limb was gently rubbed, so as to press out the thick black blood which was contained in the dilated

* *Opera Chirurgica*, p. 640. Fabricius tied the vein above and below the varix; and, having evacuated its contents by puncturing the latter, he obliterated the cavity by compression.

† *Traité des Maladies Chirurgicales*, tom. ii. p. 60—64. Paré says, that he has often employed this practice with success.—See JOHNSON'S *Translation of* PARE'S *Works*, p. 319. Dionis recommended, as one mode of treating varices, that the vein should be punctured with a lancet, and when all the blood which it contained was removed, that compression should be applied, and continued for a length of time.—See *Cours d'Opérations de Chirurgie*, p. 609.

veins. If coagulum was deposited in the vessel, the opening was enlarged, so as to permit of its extraction, and the puncture was afterwards closed with a graduated compress and bandage. The extraction of the coagulum he regarded of so much importance, that it was sometimes necessary to puncture the vein in different places for its removal, and, in some instances, even to slit open a considerable extent of the vessel. Petit observes, that bleeding from varices, whether it is the consequence of the spontaneous rupture of the vessel, or effected by art, is always attended with a remarkable mitigation of the inflammation, and an amendment of the tedious ulcers which so frequently accompany a varicose condition of the veins of the leg*. He speaks with the greatest confidence of the efficacy of this practice, and observes, that, by bleeding the varices, and confining the patient to his bed, he had cured varicose ulcers on the legs which had existed more than thirty years, and had rendered the limbs so large, that the patients were unable to walk. Petit was accustomed to take away immense quantities of blood by puncturing varices, and says that he has removed two or three pounds without causing the least weakness. It has also been re-

* *Traité des Maladies Chirurgicales*, tom. ii. p. 52.

marked by Boyer*, that larger quantities of blood may be taken from varicose veins without affecting the strength of the patient, than from healthy vessels.

I have already observed, that the pressure of the column of blood in the upper portion of the dilated vessel is a frequent cause of a varicose enlargement of the inferior veins. For the purpose of diminishing the length, and consequently the weight of the column, it has been proposed to obliterate a portion of the dilated vein by the application of a ligature. The practice of tying veins for the cure of varices appears to have been employed in the days of Paré† and Dionis‡, who have accurately described the operation of tying and dividing the vein between two ligatures. Sir Everard Home has related many cases of varicose veins in the leg, some of them being accompanied with tedious ulcers, in which, after tying the vena saphena major where it passes over the inside of the knee, not only the dilatation of the veins in the leg was relieved, but the ulcers were readily healed. In the course of a week after the operation, the veins, in general, were very much diminished in size: in all the cases, "the ulcers put on a much more healthy ap-

* *Traité des Maladies Chirurgicales*, tom. ii. p. 48.

† JOHNSON'S *Translation of* PARE'S *Works*, p. 319.

‡ *Cours d'Opérations de Chirurgie*, p. 610.

pearance in less than three days after the operation; and from that time, where no circumstance occurred to prevent it, went on healing like ulcers in healthy parts*." Although these cases terminated favourably, some of them were attended with fever, inflammation, and general loss of health, which appeared to arise from the extension of inflammation along the vein. Instances have subsequently occurred in which these symptoms increased, and terminated fatally. The high degree of constitutional irritation which is sometimes excited by the ligature of a vein was exhibited in the following case, for which I am indebted to Mr. Freer of Birmingham.

CASE LIII.

A WOMAN, about forty years of age, had long been troubled with an ulcer, which was situated a little above the ankle of the right leg. The veins of the leg and foot were varicose; and as it was probable that the intractable state of the ulcer depended upon this condition of the veins, the vena saphena major was tied with a single ligature a little below the knee. Four hours after the operation, the patient was attacked with a violent pain in the left side of the chest, which she

* *Practical Observations on Ulcers*, p. 330. Second edit.

expressed by signs only, her respiration being so quick and laborious, that she was unable to speak. Soon after the commencement of these symptoms, she vomited a large quantity of blood: her pulse was sixty in a minute: she had no pain in the leg. Fourteen ounces of blood were taken from the arm, by which her breathing was relieved, and her pulse became quicker. Four hours after the bleeding, the symptoms again increased: her breathing was more difficult, and she complained of great pain in the chest. The ligature was removed from the vein by dividing the noose which surrounded the latter. The symptoms were immediately relieved: she became easy, and her pulse rose to eighty. During the following night she vomited a little more blood: in other respects she was tolerably well, and only complained of lowness. The knee was very painful, and a little swoln on the fourth day: the pulse was feeble. The swelling and pain in the knee had subsided on the sixth day. On the twelfth day she was perfectly well in health: the wound below the knee, as well as the ulcer near the ankle, were almost healed. The sores were completely healed on the fifteenth day, but she complained of pain in the leg when in an erect position, and the veins were evidently increasing in size. On the eighteenth day the limb was very painful:

the vein appeared to be impervious below the part which had been tied, and several varices upon the calf of the leg were harder than before the operation. The veins around the ankle, however, were very turgid, and she complained of great pain in that situation. About six weeks after this operation, a large vein, a little above the outer ankle, was tied with a single ligature, which was immediately removed. She became feverish soon after the operation, and vomited twice, but did not discharge any blood. Fourteen ounces of blood were taken from the arm: in the evening the pulse was natural: the limb was painful, but the pain abated when the roller was removed. During the following day her pulse was natural: as she had been troubled with retention of urine during the last twenty-four hours, a catheter was introduced into the bladder, and three pints of water were removed. On the following day the urine was again retained, but in the evening a natural evacuation of that fluid relieved her. The operations had apparently produced the obliteration of the vessels to which the ligatures had been applied; but as other veins in the limb were varicose, and caused great pain and inconvenience, two of the largest of them were tied in a similar manner. These operations were performed about nine weeks after the last which has been described. The ligatures were

cut away immediately after their application. In three hours the patient vomited a fluid slightly tinged with blood. Sixteen ounces of blood were taken from the arm, and the pulse, which, before the bleeding, was full, became softer and quicker. The vomiting had not returned on the following day: her pulse was slow and weak, and she was troubled again with retention of urine. On the second day her pulse was almost imperceptible: she was attacked with delirium and severe vomiting, which were relieved by an opiate. On the third day the symptoms had increased, but were mitigated by taking eight ounces of blood from the arm. The pulse was scarcely to be felt on the fourth day, and the other symptoms continued as before. On the fifth day she was sensible, but on the sixth she was slightly delirious, and her respiration was much oppressed: her pulse was quick. Eight ounces of blood were taken from the arm: the pulse became fuller after the bleeding. From this time her health continued to improve: the incisions healed, and in a little time she could walk without difficulty. Two years afterwards she walked nine miles to visit her surgeon, and felt no inconvenience from her former disease *.

* In this case the obliteration of the vein was the consequence of the application of a ligature, which was imme-

As the division of veins in amputations, and other wounds, is never, or very rarely followed by those violent symptoms which are sometimes the consequence of tying a dilated vein, it was proposed, for the relief of varicose veins, to obliterate a portion of the vessel by cutting it across, and suppressing the hæmorrhage by the application of compresses and bandages. This practice has been tried, but in the following cases it was succeeded by symptoms which terminated fatally.

CASE LIV.

A MIDDLE aged man had long been troubled with a varicose state of the veins of his left leg, and an indolent ulcer which was situated near the ankle of the same limb. On the twenty-sixth of June, 1809, the vena saphena major was exposed by dividing the skin covering the vessel where it passes over the inner condyle of the femur. The vein was then cut across with a probe-pointed bistoury. The gush of blood which took place immediately after the division of the vein was

diately removed. When a vein is tied with a thin ligature, the internal surface of the vessel is lacerated; inflammation takes place; and, if the opposite sides of the tube be retained in contact by compression, their adhesion is speedily accomplished.

readily stopped by pressure. The edges of the wound were retained in contact with adhesive plasters, over which a compress was fixed by means of a common roller. The patient suffered but little pain during the operation; afterwards he complained of faintness. In the evening, and on the following day, he was well in health, and in no pain. He took a purgative draught, which procured two or three evacuations. About three o'clock in the morning of the second day after that on which the operation was performed, he had a shivering fit, and was rather light-headed. At noon his pulse was weak and quick; his tongue was slightly furred; he complained of sickness and headach; he was restless; his strength was depressed, and his countenance had assumed an appearance of great anxiety. He said he had no pain in the limb: he did not complain when it was pressed, nor was it tense or red. The bandages and plasters were removed: the wound had not united, but it looked healthy. A poultice was applied to the sore, and he took a draught composed of camphor mixture, antimonial wine, and opium. In the evening he was a little stronger: thirty-five drops of tincture of opium were given to him. On the morning of the third day he was sick, and vomited up some food which he had taken for breakfast. At noon his pulse was

frequent and low: his tongue was covered with brown fur: he complained of headach, and was much depressed. There was some redness of the thigh, but very little pain or tenderness. In the evening the redness, pain, and tenderness of the thigh had increased, and extended up the limb in the course of the vena saphena major. His pulse continued low and frequent. Eight ounces of blood were taken from the thigh by cupping, and the opiate was repeated. During the night he sunk, and died about three o'clock on the morning of the fourth day.

Upon dissection, the inguinal glands were found to be a little enlarged. The small veins in the adipose substance on the inside of the thigh were loaded with blood. The external wound contained a small quantity of matter. The extremities of the vena saphena major, which had been divided in the operation, were united by coagulable lymph. A portion of the vein below the wound was a little contracted in its diameter, but in other respects it had a natural appearance. The whole of the vein above the wound, as far as its junction with the femoral vein, was removed. Its internal coat was rather redder and more vascular than natural: no coagulable lymph or pus was effused into its cavity, nor was any other præternatural appearance observed in it. The contents of the abdomen were

examined, but all the viscera were in a healthy state. A portion of the vena cava which was removed had a natural appearance.

CASE LV.

A SMALL ulcer was situated near the outer ankle of the left leg in a man thirty-two years of age. The veins of the leg had for several years been in a varicose condition, and, a short time before his admission into the hospital, one of the dilated branches of the vena saphena minor, on the outside of the foot, burst, and a considerable hæmorrhage was the consequence. On the twenty-seventh of December, the vena saphena major was divided a little above the knee. The wound had united in fourteen days, and the sore near the ankle soon healed. It was remarked, during the operation, that the divided vein was so small as to render it doubtful whether it was the saphena major or a collateral branch. The varicose enlargement of the veins of the leg was but slightly diminished at the end of a month after the operation, although constant pressure had been applied to the limb. A considerable varicose vein was felt extending across the ham from the vena saphena major to the vena saphena minor. As this communicating branch appeared

to defeat the objects of the former operation, it was determined that it should be divided. For this purpose an incision was made through the integuments covering this vein near the place where it opened into the vena saphena minor. The vein was then cut across: a compress of lint was placed upon the wound, and secured in its situation by means of a roller. On the evening of the following day the patient complained of headach, but had not more pain in the wound than was to be expected. The headach having continued, his tongue being furred, and his bowels constipated, a purgative medicine was given to him on the third day after that on which the operation was performed. The operation of the medicine, however, was not attended with an abatement of the pain in his head, which, on the fourth day, increased considerably, and was followed at night by slight delirium. On the fifth day he complained, for the first time, of pain in the limb, not, however, in the situation of the last wound, but in that of the former, which had now been healed for some time. The pain extended up the thigh. On the sixth day the pain in the thigh was much increased: his skin was hot; his pulse more frequent; and the delirium still continued. In the morning of this day the wound looked well, but in the evening the thigh

was much swollen: the pain in the course of the vena saphena major was so excruciating, that he could scarcely permit the part to be touched, and it was with much uneasiness that he was placed in a tub to receive an affusion of cold water, which had been ordered in the event of his skin continuing hot. The affusion appeared to relieve the headach for a time, and he felt upon the whole relieved by it; but, before eleven o'clock at night, the headach returned with unusual violence, and was attended with constant muttering. His face being flushed, and his pulse full, fourteen ounces of blood were taken from the temporal artery. The roller was removed from the thigh, to which a saturnine lotion was applied, and on the following day the wound was covered with a large poultice. A profuse perspiration came on: the delirium was incessant, and continued until he died. Permission could not be obtained to examine the body.

Sir Everard Home has observed, that "cases occur in which there is a smaller vein running parallel to the vena saphena. This, when the vena saphena has been taken up, afterwards becomes enlarged, and continues the disease*." In

* *Practical Observations on Ulcers of the Legs*, &c. p. 299. Second edition.

one of the cases* related by Sir Everard Home, the veins of the leg increased in size some time after the operation. Fifteen months after the vena saphena had been tied, a vein, in the place where the ulcer had formerly been situated, burst, and bled freely. At the part where the ligature had been applied, two very large veins were discovered, and were included in one ligature. In a case which I have related† the veins around the ankle became varicose after the vena saphena major was obliterated, and the circulation appeared to be carried on partly by a dilated vein running parallel to the vena saphena, and partly by anastomosing branches opening into the vena saphena minor. In the following cases varices in the leg enlarged some time after the ligature of the vena saphena major: the circulation was carried on in the same manner as in those instances to which I have now referred.

CASE LVI.

A WOMAN, at this time about forty years of age, has for twenty years been afflicted with varicose veins in both her legs. Nine years ago she went into a hospital for the cure of an ulcer which

* *Practical Observations on Ulcers of the Legs*, &c. Case II. p. 308.

† Case LI. page 542.

was situated a little above the ankle of her left leg. As the veins were very much enlarged, the vena saphena major was tied in both limbs at the same time. She tells me, that the strings with which the vessels were tied remained in the wounds several days, and came away of their own accord. The ulcer healed, and the veins in the leg appeared to be stationary while she was in the hospital, and at rest. But, some time after she had returned to her employment as a servant, the ulcer again broke out, and the veins were as large and troublesome as before the operations. Six years after the operations a prominent varix, situated a little above the ulcer, burst, and bled profusely. The hæmorrhage was stopped by the application of a compress and bandage: the patient was afterwards confined to her bed for several weeks, during which time the ulcer healed. Nearly three years have now elapsed since I first saw this patient, shortly after the varix burst. She has continued the use of her bandages, and the ulcer is healed; but the veins in both legs are remarkably varicose, and in some places form prominent swellings. In both limbs a large vein exists in the course of the vena saphena major, and is evidently the principal channel through which the blood is conveyed from the varicose veins of the leg. Underneath the scars where the vena saphena major was tied, in both limbs, this collateral vein is particularly dilated.

CASE LVII.

In the year 1807 the vena saphena major was tied in a middle-aged man, in consequence of a varicose condition of the veins of the leg, which caused great pain and inconvenience. A single ligature was applied, and it continued on the vein several days: the patient recovered without any unfavourable symptoms. The veins around the ankle diminished after the operation, and the man being relieved from the inconveniences of the disease, returned to his business, which required that he should be constantly upon his legs. About five years afterwards, when I saw him, he was under the care of his surgeon, in consequence of the veins in his leg being as large and troublesome as before the operation. A large vein was observed in the course of the vena saphena major, passing underneath the scar which existed at the place where the vein had been tied.

From the preceding observations it is evident, first, that the ligature or division of varicose veins sometimes produces alarming, and even fatal consequences; and, secondly, that the disease in the branches sometimes increases after the obliteration of a portion of a varicose venous trunk.

Another mode of preventing the enlargement of varices, by relieving the inferior veins from

the pressure of the column of blood in the upper portion of the dilated vessel, consists in keeping the limb in a horizontal posture, and the employment of compression. Every surgeon is aware of the benefit which is derived from confining the patient to his bed, and bandaging the limb, in the treatment of varicose ulcers of the legs. Until the ulcer is healed, a common roller is the most convenient bandage; but, after this object is effected, a laced stocking is generally preferred, because it can be applied with greater facility and accuracy by the patient. In this country the laced stocking is commonly made of linen: foreign writers* have particularly recommended that it be composed of leather. But the mode of compressing the limb with the greatest accuracy, for the purpose of preventing the enlargement of varicose veins, consists in surrounding it with a bandage composed of strips of linen thinly spread with a mild adhesive plaster, which in general is also a suitable application to varicose ulcers. It is probable, when the dilatation is confined to a small portion of the vein, that powerful compression, by means of a firm compress, and adhesive straps, by stopping the circulation through the vessel, may ultimately effect a cure of the

* Dionis, Petit, Boyer.

disease. Astringent solutions have been much extolled as applications to varicose veins, and benefit has occasionally been derived from the application of powdered ice, enclosed in bladders, or of water in which ice has been dissolved. Blistering the skin which covers varicose veins has also appeared to promote the contraction of the dilated vessels.

Varicose enlargements of the veins of the scrotum and testicle rarely require any other assistance from surgery than the constant use of a suspensory bandage, by which the increase of the disease is generally prevented. Cases of cirsocele have, however, occurred, in which the pain and inconvenience were so great, that the patients submitted to castration *, and in some instances only the varicose veins have been extirpated †. Sir Everard Home has related a case in which he divided the integuments, and tied a large varicose vein coming from the testicle: symptoms of fever were the consequence; but, when the wound had healed, "the testicle and its vessels were diminished to one-half of the size they had acquired before the operation." Nine months afterwards another vein of the same testicle was tied,

* See Gooch's *Surgery*, vol. ii. p. 244.

† See Charles Bell, *Operative Surgery*, vol. i. p. 354.

and, in a few days, the testicle was much reduced in size *.

Various kinds of tumours which are met with at the inferior part of the rectum, and the verge of the anus, are denominated hæmorrhoids. Sometimes these tumours consist of a varicose enlargement of the branches of the hæmorrhoidal veins. The dilated vessels occasionally burst, and in some instances the hæmorrhage is so considerable as to require the employment of cold and astringent lotions and compresses. In some instances the bleeding occurs at certain periods, and is considered salutary; for, in such cases, the suppression of the discharge appears to be injurious to the general health of the patient. Under these circumstances, if a return of the bleeding cannot

* *Practical Observations on Ulcers of the Legs*, &c. p. 353. Second edition. A varicose enlargement of the spermatic veins is more frequently mistaken for an omental hernia than any other disease. Mr. Astley Cooper has given the following rule by which the two diseases may be distinguished: Place the patient in a horizontal posture, and empty the swelling by pressure upon the scrotum: then put the fingers firmly upon the upper part of the abdominal ring, and desire the patient to rise: if it be a hernia the tumour cannot re-appear as long as the pressure is continued at the ring; but, if it be a cirsocele, the swelling returns with increased size, on account of the return of blood into the abdomen being prevented by the pressure.—See COOPER *on Inguinal Hernia.*

be induced by the use of warm fomentations, relief may generally be obtained by puncturing the dilated vessels with a lancet, or by the application of leeches. The blood sometimes coagulates in the dilated vein, and the swelling becomes hard, inflamed, and very painful. The coagulum is subsequently absorbed, but the thickened coats of the vein and the surrounding parts form a tumour, which is liable occasionally to inflame, and afford great distress to the patient. On this account the removal of the tumour by a surgical operation is sometimes necessary; but when the disease is in this state, its treatment is the same as that of hæmorrhoidal excrescences arising from other causes, and cannot be regarded as a part of the present subject.

APPENDIX.

An Account of the Worms which are found in the Arteries of some Animals.

It is known to those who have dissected horses and asses, that worms are frequently found in the mesenteric arteries of these animals, and that the vessels containing them are remarkably diseased. Being desirous of examining this disease, I procured opportunities of dissecting several asses, because I was informed that it was more frequent in these animals than in horses, and the following are the results of my investigations.

The most frequent seat of the disease is the superior mesenteric artery: in one instance I found it also in the cœliac artery, and in this animal the aorta at the origin of the cœliac and mesenteric arteries was considerably dilated. The superior mesenteric artery, immediately after its origin from the aorta, is gradually dilated into a sac, varying in its transverse diameter from half an inch to an inch and three quarters. In some instances the disease does not occupy more than an inch of the vessel, which is dilated into a round hard tumour. Sometimes the whole extent of the vessel and its principal branches are diseased, and form thick cords lying in the mesentery. The tumour consists of the three

coats of the artery, which are remarkably thickened and dilated. Sometimes the dilated coats of the vessel are soft and pulpy: sometimes they are hard, and of a dense tendinous structure: in one instance a deposition of calcareous matter had taken place in the internal coat. The external coat is not in general more intimately attached to the surrounding parts than in its natural state. The internal surface of the vessel in some places is smooth and polished: in other places it is irregular and rough, in consequence of the adhesion of flakes of lymph or coagulum*. In some specimens the lymph merely lines a part of the cavity: in others it is deposited in irregular masses; and in three of the instances which I have examined, it was accumulated to such an extent, as completely to obliterate the cavity of the superior mesenteric artery. In one of these instances a considerable quantity of pus was mixed with the lymph, which in general is irregularly lamellated, and of a lighter colour than the coagulum which is commonly found in aneurismal sacs. Numerous small round worms are imbedded in the lymph. Sometimes the worms are found in the cavity, unconnected with the lymph or the coats of the vessel; but when the vessel is pervious, their heads generally project into the cavity, and are of a faint red colour. I have found more than thirty of these worms in one animal: in some instances I have only discovered three or four: their number is generally proportionate to the quantity of lymph contained in the vessel. For the purpose of investigating this subject, I have examined

* See plate VIII. fig. 2.

nine asses, in seven of which I found the worms and the disease which I have described in the superior mesenteric artery: in one instance the coats of the artery were dilated and thickened, but neither lymph nor worms could be discovered in it: in only one instance the superior mesenteric artery was healthy. The animals were of various ages: the youngest in which the worms were found was said to be two years of age: the mesentery of that in which the largest number of worms was found, and in which the cavity of the artery was obliterated, was remarkably fat: the animal appeared to have been in perfect health before the accident on account of which he was destroyed.

The worms which I have examined vary in length from half an inch to an inch and a quarter. Immediately after the death of the animal in which they are contained, they are semi-pelucid; but exposure to the air, or immersion in water or weak spirit, soon renders them of an opaque white colour. The head is obtuse, and the tail pointed. A white convoluted line, which I conceive to be the intestinal tube, commences at the head, and terminates a little above the extremity of the tail *. When examined under a microscope, several longitudinal lines are observed passing down the surface of the worm, which is intersected by numerous transverse rings. I was not able to make any satisfactory observations as to the sexual organs. I have only once

* See plate VIII, fig. 3.—My friend, Dr. Leach, Zoologist to the British Museum, did me the favour of examining some of these worms: his observations coincided precisely with my own.

observed a slight motion in one of the worms: although I have examined them a few minutes after the animal containing them was killed, they have been dead in every other instance except that which I have mentioned.

The existence of these worms has been noticed by several writers, but I am not aware that the disease in the coats of the artery has hitherto been accurately described. Ruysch says, that he found a cluster of worms in the aorta of a horse *. Schulzius found an aneurism in the artery which runs along the colon in a mare. On examining the inside of the tumour, which was formed by the coats of the artery three times thicker than natural, "he observed that its substance was quite cellular, and that the cells were full of capillary worms twisted together †." Sabatier ‡ mentions the observations of Ruysch, Schulzius, and Morgagni. The latter found the aorta of a dog studded with tubercles containing worms ||. Rudolphi frequently met with worms in the mesenteric arteries of horses. He describes them as a variety of the strongylus armatus, under the denomination of strongylus armatus minor, aneurismaticus. He says that the strongylus armatus major is more frequently found in the large intestines of horses and mules, than any other kind of worms,

* *Opera*, tom. i. obs. 64. and dec. iii. art. 6.—Ruysch has given an outline of the worms in the plate at p. 61.

† *Acta Nat. Curios.* vol. i. obs. 219. p. 519.—See SCARPA, *Treatise on Aneurism*, WISHART'S *Translation*, p. 84.

‡ *Médecine Operatoire*, tom. i. p. 355.

|| *Epist. Anat.* 9. n. 44, 45.

and that the strongylus armatus minor does not differ from it, except in its size *.

It has been supposed that the worms are originally formed in tubercles or sacs attached to the external surface of the artery, and that the coats of the latter being destroyed in consequence of the pressure of the sac, a communicating aperture is formed between the two cavities, through which the worms are admitted into the artery †. The nature of the disease in the coats of the vessel, however, refutes this opinion; for, in the specimens which I have examined, it has invariably consisted of an uninterrupted dilatation and thickening of the three coats of the vessel. Nor have I ever seen tubercles in the vicinity

* *Entozoorum, sive Vermium Intestinalium, Historia Naturalis*, vol. i. p. 437, and vol. ii. p. 204. The following is Rudolphi's description of this species of strongylus: "Capite globoso-truncato; ore aculeis rectis densis armato; bursa maris triloba; cauda feminæ obtusiuscula." In the first worm from the mesenteric artery of an ass which I examined, several aculei projecting from the head were very apparent, when examined under a microscope; and I represented them in a drawing taken from this specimen before I had seen Rudolphi's work. But in subsequent examinations I have never discovered these aculei. Although there can be little doubt that these worms belong to the genus strongylus, as described by Rudolphi, this circumstance appears to me to render it doubtful whether they are always of the species denominated strongylus armatus, of which the aculei surrounding the mouth form the characteristic distinction. My friend, Mr. Barnes of Exeter, recently sent me a specimen of this disease in the mesenteric artery of a horse: the condition of the vessel, and the appearance of the worms under a microscope, coincided in every respect with those specimens which were taken from asses.

† Rudolphi, *loc. citat.*

of the artery, or any other appearance in the surrounding parts, which sanctioned this supposition. It has also been conceived that these worms are formed in the intestines, and having penetrated the sides of these tubes, traverse the mesentery until they arrive at the artery. Were this, however, the case, it is reasonable to expect that some of them would be found in other parts of the mesentery. Although I have attended to this point, I have never found them in any other situation than the artery, which has not exhibited appearances that could justify the supposition that the worms had penetrated its coats from without. This idea also does not account for the frequency of their existence in the superior mesenteric artery of animals in which the other branches of the abdominal aorta, as well as the contiguous veins, are altogether free from disease. It appears probable that the worms are the cause of the disease in the coats of the artery, and that their formation is not the consequence of the dilatation of the vessel, or the deposition of the lymph which it contains: for, in aneurismal sacs containing coagulum, which have been so repeatedly examined in the human subject, I believe that worms have never been discovered.

The cases upon record in which worms are said to have been found in the blood vessels of the human body *, are, at this time, I believe, generally regarded

* Ploucquet refers to numerous cases in which worms were said to have been found in the heart and veins. M. Peysson of Montpellier found five or six living worms in the right ventricle of the heart of a dog which had for some time appeared in bad

as fabulous; and the appearances which have been described are referred to the various forms which fibrine deposited from the blood occasionally assumes. That worms should be capable of existing in the blood vessels is not so surprising as that they should inhabit cavities containing bile, urine, or the intestinal secretions; but their admission into the former does not admit of so ready an explanation as their introduction into those cavities which communicate with the surface of the body. The discovery of parasitical animals in the fœtus *, proves, however, that their introduction with the food, or their admission through any of the common passages of the body, is not essential to their existence; and it is difficult to conceive in what manner the worms which I have now described, or the germs from which they spring, are admitted into the arteries.

health, and was frequently attacked with convulsions. The worms were from eight to ten inches in length, of a cylindrical form, and pointed at both extremities. They moved about for a short time after they were placed upon a table. The parietes of the ventricle were healthy, and no worms could be found in the other cavities of the heart, or in the great blood vessels. — See *Journal de Médecine*, par Corvisart, Leroux, et Boyer, tom. xi. p. 441.

* Ruldolphi mentions a considerable number of instances of this description. — See *Entozoorum Historia*, vol. i. p. 387.

Case of Obliteration of the Brachial, Radial, Ulnar, Femoral, Popliteal, and Tibial Arteries.

For the following interesting case I am indebted to Dr. John Thomson, Professor of Surgery to the Royal College of Surgeons, and Regius Professor of Military Surgery in the University of Edinburgh.

Mr. H., about thirty-six years of age, of a full habit of body, on the first of January, 1814, after being exposed to cold, was attacked with alternate cold and hot fits, which continued until the ninth, when he applied to me for advice. His face was flushed, and his eyes red: his pulse quick: the evacuations from his bowels were frequent, and of a highly bilious nature. He had occasionally a short cough, and complained of oppression in his chest. Purgative medicines were prescribed, and low diet and rest enjoined. For several days the evacuations continued bilious, he had occasionally cold fits, and had two attacks of bilious vomiting. On the fifteenth he thought himself much better, and fatigued and exposed himself by getting up and leaving his bedroom. On the following day he complained of a diffused pain over the right side of the chest, with oppressed breathing, and a short cough. His pulse was ninety-six. He had a return of the cold fits and bilious evacuations. My friend, Mr. Turner, who attended Mr. H. with me, bled him to the amount of twelve ounces: the aperient medicines were continued. The blood was not buffy. The cough abated,

and the pain which was removed from the chest extended down the side: two days afterwards it attacked the right groin near the insertion of the pectineus muscle, extending down the leg, and particularly affecting the calf of the leg and the sole of the foot. This pain continued violent for two days, and alternated between the groin and the calf of the leg. There was considerable heat in the painful part of the thigh, and the femoral artery throbbed very violently in the groin. The fever continued about a week: the pulse was 96: the skin warm, and generally covered, once in the day, with a free perspiration. A solution of the fever seemed about to take place, when, after fatigue, he was again attacked with rigors, accompanied with great depression, and an affection like globus hystericus. The fever continued without amendment, his pulse varying from 112 to 94.—February 7th. A slightly hard and painful swelling was observed on the inside of the calf of the right leg: this swelling disappeared spontaneously.—February 11th. His pulse fell to 70, and he passed an indifferent night, with a sense of oppression in the chest. The pulse beat twice every fifth stroke, and was rather soft. Port wine was given instead of claret, of which, with the advice and concurrence of Dr. Hamilton, who had been consulted, and who, during its subsequent progress, gave the case unremitting attention, he had been allowed three or four glasses daily. After taking three glasses of port wine the pulse became more firm and regular.—13th. Has had three copious evacuations from his bowels of a very black colour,

and not unlike dissolved blood. A severe rigor was followed by profuse sweating. Pulse quicker and regular, though feeble. Complains of extreme languor: his countenance has fallen, and he has lost his recollection of past events.—14th. Had another rigor and sweating. Continues very weak and low, without return of memory. Drank nearly a bottle of wine in the twenty-four hours.—15th. Is better, being collected, and less languid.—20th. The evacuations from his bowels are lighter, but have not resumed their natural colour. Began to take a mercurial pill every evening, which was discontinued after twelve days, his mouth being slightly affected. He continued to improve in strength, passed good nights, his appetite was improved, and the evacuations from his bowels began to assume a more natural appearance. His pulse was generally about 84, and he was so far convalescent as to be able to go into the next room, when he became the subject of a new series of complaints.

On the 5th of March, about ten o'clock in the forenoon, whilst raising himself in bed by resting on the palms of his hands, with his arms stretched behind him, he experienced a sensation as if something had suddenly given way at the elbow joint of the right arm. This occurrence was immediately followed by numbness of the hand and fore-arm, and a feeling of circumscribed tightness across the fore part of the elbow joint. The hand soon became cold: on trying to feel the pulse at the wrist, he was surprised and alarmed to find that it had entirely ceased. About two hours afterwards, when

I saw him, no pulsation could be felt at the wrist, nor in any part of the fore-arm below the place where the brachial artery passes under the tendinous expansion of the biceps, at which spot he experienced a sensation as if a cord were tied across the limb. Above this part the pulsation of the artery was strong, and where it crosses the elbow joint it appeared stronger than in the other arm. The pulsation was entirely confined to the artery. No tumour could be observed, but the artery, when held between the finger and thumb immediately above the place where the pulsation ceased, seemed rather larger and harder than in the opposite arm. The numbness continued: the hand was pale and cold, but the powers of motion and sensation were perfect. The pulse had been felt daily in that arm for several weeks, and on the preceding day was in its usual state. During the fever, the pulse, particularly in the larger arteries, was strong and throbbing. He had been attacked in the morning with pain in the upper part of the abdomen, and a slight diarrhœa. His pulse was 108, full and strong, being considerably more frequent than it had been for some time, though probably accelerated by anxiety. At three o'clock Mr. Turner visited him, and found that the pain at the bend of the arm had increased. The patient compared it to the puncture in bleeding. The pain was not throbbing, but was accompanied with a pricking sensation in various parts of the fore-arm. Pressure at the elbow joint produced pain, but he could permit the parts to be freely examined. The pulsation opposite to the elbow joint

appeared stronger than in the other arm. No tumour could be distinguished. A feeble pulsation could, with difficulty, be discerned in the radial artery near the wrist, and on compressing the fore-arm the veins on the back of the wrist were observed to fill slowly. In the evening the pain became more severe, and extended along the front of the fore-arm. The pulse at the elbow joint was weaker, being rather less strong than in the same part of the opposite arm. The pulse at the wrist was very indistinct and feeble. The hand, which was covered with flannel, retained nearly its natural temperature. A draught, containing thirty drops of laudanum, was given at bed-time. A solution of acetite of lead was applied to the arm, which he was directed to refrain from using.—6th. No tumour or swelling has appeared in any part of the arm, but the parts surrounding the artery are less lax, and a slight hardness is perceptible along the inside of the tendon of the biceps muscle. The pulsation still ceases at the same point, and is not so strong as in the other arm. A very feeble pulse is felt at the wrist, but it is sufficiently distinct this evening to be counted. The pain is increased on pressure, and is most severe at the point where the pulsation in the artery ceases: it extends an inch above this point in the course of the artery, and two inches downwards towards the radial side of the arm. Motion of the elbow joint, in certain directions, produces severe pain, but he can move the fingers without the least inconvenience. The hand is warm, and the numbness has considerably abated. A compress

of sponge, moistened with a solution of acetite of lead, was placed along the artery for three inches above the place where the pulsation ceases, and a roller was applied, with moderate tightness, from the fingers to the middle of the arm.—7th. This morning, about six o'clock, whilst coughing, he experienced a severe darting pain at the bend of the arm, which induced him to remove the bandage. There is rather more fulness and hardness on the inside of the tendon of the biceps. There is no increase of pulsation. The pain is less acute on pressure, but very severe on any attempt to bend the arm, or to place it in the state of supination. The pulse at the wrist is not increased.—8th. There is much less pain on pressure, and the fulness and hardness appear, in a small degree, to have subsided. The pain on attempting supination is severe, and is described as following the course of the pronator radii teres muscle. The pulsation at the elbow joint is still more diminished; at the wrist it is weak and variable. He continues to complain of pain in his bowels, with occasional sickness.—9th. About midnight, on moving his right leg without any great exertion, he experienced a sudden sensation of numbness and weight, extending from the ham downwards. This sensation was very similar to that which occurred in the arm. The pulse was immediately felt for at the ankle and foot, but it had entirely ceased. Upon the arrival of Mr. Turner, about half an hour after this occurrence, no pulsation could be felt in the ham, or in any part of the leg. The femoral artery was beating very strongly, and its

pulsations could be felt down the thigh to the part where it perforates the tendon of the triceps adductor muscle. The pulsation in this thigh was considerably stronger than in the other, though in the latter it was very strong and throbbing. No tumour or swelling could be perceived in any part of the leg. The foot was cold, and he occasionally complained of a cramp-like pain, in various parts of the calf of the leg. No pain was produced by pressing any part of the limb. He was advised to surround the foot with flannel, to place the limb in the easiest position, and to use moderate friction on the calf of the leg when the pain recurred. He passed a bad night on account of a burning pain in the ankle and foot, and a feeling as if the foot were crushed. This pain still continues, though not so constantly. It is excited by any motion of the leg or foot. The foot feels benumbed, and below the ankle it seems entirely devoid of sensation, for he does not complain when the integuments are pinched. He can move the toes and ankle, but the motion of the toes appears to be effected by the muscles arising from the leg; no action is perceptible in the muscles of the foot. The foot becomes rapidly cold when exposed. When covered with flannel it retains nearly its natural temperature. No pulsation can be felt below the part formerly mentioned. The pulsation of the femoral artery is remarkably strong, particularly at the groin. At the origin of the profunda it communicates a sensation like a pulsating tumour. He complains of pain when pressure is made in the course of the artery at the lower

and inner part of the thigh, or in the ham. At the bend of the elbow the pain on motion or pressure is much diminished. A degree of hardness is felt in the course of the brachial artery, extending an inch and a half above, and the same distance below the point where the pulsation ceases. Sensation and voluntary motion in the arm are perfect. Pulse 108, and full: it communicates, in the larger arteries particularly, a whizzing sensation. A strong pulsation is observed in the abdomen along the course of the aorta. His bowels are regular, his tongue clean, and his skin warm and moist. It was recommended that the foot should be occasionally moved, so that pressure might not be long continued on any one part of it, and that the friction should be omitted.—10th. The pain, which had diminished during the night, recurred in the morning. The foot has a tendency to be cold, although covered with flannel, and surrounded with bottles of warm water. Several patches were observed this morning over the instep, and on the fore part of the leg, about two inches above the ankle, of a mottled purple colour, which, when examined, appeared to be composed of small vessels, filled with blood. These patches were attended with no swelling or hardness, and do not change their appearance upon pressure. The foot continues insensible: in the evening a little moisture was observed upon it. Severe pain down the back of the leg is excited by compressing the artery under the triceps, and by motion of the knee. The pain in the arm is nearly gone. The pulsation of the brachial artery continues as far as the tendinous expansion of the

biceps, but it is not so strong as in the opposite arm. The pulse at the wrist is become rather more distinct. Pulse 108: tongue rather whiter than it has been for several weeks: bowels regular. He perspires profusely on the least exertion, or after eating, and when asleep: he cannot lie on his left side. The action of the heart, at repeated examinations, has appeared to be natural, though vigorous.—11th. He is extremely restless, and has suffered much pain during the night. The temperature of the diseased foot continues lower than that of the opposite side, and there is no return of sensibility. The efflorescence has become more continuous. Several small veins, of a dark blue colour, are observed on the surface of the foot, as are also some larger branches about the ankle. They are emptied by gently rubbing the finger over them, and they fill again slowly. Pressure produces severe pain in the inner and lower part of the thigh, in the ham, and top of the calf of the leg. When the leg is moved he suffers great pain. Whilst the bandage was being applied to the leg to-day, he was seized with palpitations, sickness, and faintness. Pulse 110: the perspirations are very frequent and profuse. His bowels were regulated by pills of rhubarb: he took an opiate at bed-time, and about six glasses of wine in the course of the day. —12th. The pain in the foot has considerably abated. Numerous branches of veins are seen about the roots of the toes, and on the surface of the foot. When emptied by pressure, they fill again. The temperature of the foot is rather increased.—13th. In the evening of yesterday, the foot assumed a diffused dingy red

colour, which disappeared on pressure, and returned slowly. It was swoln; and several patches of efflorescence were observed on the sole of the foot, which retains the same appearance to-day. The branches of veins are much less distinct. The foot is nearly of the natural temperature. He is much less restless and agitated than on the preceding evening: he has less pain in the ham and in the lower part of the thigh, and can bear motion and pressure with less inconvenience. The pulsation of the artery at the lower part of the thigh is not so strong. Pulse 118.—14th. He was free from pain, but did not sleep during the night. The foot is livid, cold, and œdematous. The colour does not disappear so readily on pressure, and the ramifications of veins are less apparent. He complains of pain on pressing the leg a little above the ankle, where there is fulness. The temperature of the leg down to this part is natural. He has several times to-day been attacked by a pricking pain in the left great toe, extending to the ham. Pulse 108, and softer. He has continued the wine and the opiate, and is ordered a scruple of cinchona three or four times a-day. —15th. He is restless, without sleep, and unable to lie in the horizontal posture. The foot is more livid and hard. Swelling is taking place immediately above the ankle, with pain on pressure, and heat. He has pain in the femoral artery in the groin when he coughs. The pulsation in that situation is not so strong as when first described. Pulse 112, and weaker. —16th. He complains of severe burning pain in the ankle and foot. Several vesicles have appeared on

the foot. The swelling, hardness, and heat of the leg have increased, and extend as far as the lower part of the outside of the calf. Pulse 110. The wine, opiate, and cinchona have been continued.—17th. The inflammation has extended up the calf of the leg, with increased heat, but no redness. He complains of severe pain on pressure or motion, but at other times he is easy. The foot has the same appearance as yesterday: it is not cold. He takes thirty drops of laudanum every four or six hours. Pulse from 114 to 120.—18th. He has passed an easy night, and has taken about one hundred drops of laudanum, at three doses. Complains less of the pain in the leg when it is pressed. The foot is very livid, and above the ankle there is a considerable degree of the freckled appearance which at first took place on the foot. The vesications on the foot are increasing.—19th. Several large vesications have appeared above the ankle, particularly on the back of the tendo Achillis. The calf of the leg is swoln and œdematous. He has suffered considerable pain in the leg and foot. He appears weaker, and has perspired much. Pulse from 110 to 114, and much softer. He takes about thirty-five drops of laudanum every four hours.—20th. The opium has allayed the pain, but he appears languid, and has been troubled with laborious breathing, which affected him very severely about three o'clock, and terminated in a severe fit of coughing, when he expectorated a considerable quantity of mucus, of a red colour. Pulse 120. He complains of soreness in his throat, which appears slightly aphthous. The livid appear-

ance extends three inches above the ankle, and terminates abruptly, without any inflammatory redness at its margin. Pressure produces no pain in the livid parts, but very acute pain immediately above them. No appearance of veins on the foot or round the ankle. A lotion composed of equal parts of warm vinegar and water was applied to the leg. The cinchona was omitted, and the opiate and wine continued.—21st. His breathing is constantly quick and laborious, with aggravated paroxysms. The bloody expectoration appears to be facilitated by a mixture containing the aromatic spirit of ammonia. Pulse 120. He complains but little of his leg.—22nd. He appears more feeble. Pulse 120 to 126. He complains more of the pain in the leg. The discoloured parts of the leg and foot have obtained a bright red hue since the application of the vinegar.—23rd. This morning he appeared very feeble and exhausted, though in the night his breathing was easier. The bloody expectoration is abated. Pulse 120 in the morning, but has fallen during the day to 108: it is soft and feeble. He perspires much: his skin is clammy: he has excessive thirst and little appetite. Since last night the integuments on the outside of the leg, nearly as high as the knee, have become of a dark purple colour, and several vesications have appeared upon them. He complains of little pain in any part of the leg, even when it is pressed. The mixture with ammonia is omitted.—24th His breathing, though hurried, is less oppressed. Pulse 108, and feeble: it cannot be felt in the radial artery of the right wrist.—25th. He

perspires profusely, and drinks much. His breathing is evidently less hurried. Pulse in the morning 108: in the evening 98, and soft. Tongue dry, and covered with a dark fur. The whole leg is discoloured.—26th. He is in less pain, and his breathing is not so difficult. Pulse from 90 to 94. His intellect was slightly incoherent about mid-day, but at other times he has been collected. He has taken a little wine, and the opiate every six hours. —27th. About twelve o'clock last night he became uneasy, and continued so for half an hour. Whilst sitting up to have his pillow moved, he fell back suddenly, and, after two or three deep inspirations, expired. For some time before his death he possessed perfectly the sensation and voluntary motion of his hand and fore-arm. A slight hardness continued in the course of the artery at the elbow joint, but he had no pain in that situation. The pain at the lower part of the thigh, and in the ham, had entirely subsided.

Dissection.—The brachial artery was exposed, and traced to the fore-part of the elbow, where it was imbedded in a hardened mass composed of the surrounding cellular membrane, veins, and nerves, which adhered firmly to each other and to the artery. When the latter was slit open it was found to be impervious immediately before dividing into the radial and ulnar arteries. At that part its calibre was much contracted, and filled with a cylindrical clot of firm lymph, which extended about a quarter of an inch upwards from the division of the vessel, and adhered firmly to its internal surface. The

orifice of a large branch was situated immediately above the termination of this clot of lymph. The radial artery was obliterated for near an inch and a quarter: its calibre was much contracted, and filled with lymph adhering firmly to its internal surface, and terminating in a delicate conical process, about two lines in length, which projected downwards into the tube of the artery. The obliteration extended only to the commencement of the ulnar artery, the internal coat of which terminated near the upper part of the obliterated portion of the vessel in a distinct edge, proceeding about half an inch down the artery in an oblique direction. The coats of the artery in the obliterated space were hard, thickened, of a whiter colour than natural, and adhered inseparably to the surrounding parts. Above and below the obliterated part, the vessel appeared sound in every respect. On cutting into the inferior extremity, a considerable effusion of a clear serous fluid was found in the thigh and upper part of the leg, and the muscles were rather pale. But lower down, where the skin was discoloured, the muscles were of a dark colour, very flaccid, and easily torn: in the course of the incisions copious coagula of black blood were brought into view. On tracing the vessels, considerable hardness and adhesions were found where the femoral artery perforates the tendon of the triceps, and in the upper part of the ham. When the artery was slit open, an oval sac was found in its course immediately after the vessel passed through the tendon of the triceps. This sac

contained a hard solid substance resembling lymph, of the size and shape of a nutmeg. The surface of this coagulum was covered with a thick greyish coloured fluid resembling pus. The coagulum was unconnected with the containing sac, except at the upper extremity of the latter, where it adhered very firmly. Immediately above this sac the tube of the artery was obliterated to the extent of half an inch. Its coats were much thickened: its parietes were in contact, and adhered to each other. From the obliterated portion a large conical clot of coagulable lymph extended up the vessel for three inches. To the distance of more than an inch and a half below the sac the coats of the artery were thickened, and its cavity was filled with a very firm coagulum of lymph, which adhered firmly to its internal surface, and sent a strong conical process half an inch in length downwards. The sac appeared to consist of several layers. The inner of these arose from the coats of the artery, but no appearance of the internal coat of the artery, or of circular fibres, could be observed. At the attachment of the sac to the inferior portion of the artery, the internal coats of the vessel terminated in a ragged margin. The inner layer of the sac appeared to be composed of the dilated external coat of the artery, and the other layers appeared to be formed by the surrounding cellular substance. Beyond the lower obliteration the popliteal artery was pervious, and empty for the extent of about two inches: it appeared sound in every respect, except in there being a crucial fissure or laceration of the internal coats, opposite

to the origin of a large branch which arose from this portion of the vessel. Below this part the artery was again obliterated to the extent of an inch and a half by lymph effused into its cavity and adhering to its parietes, though not so firmly as in the obliterated portions already described. This closed portion terminated in a thin sac, which would contain a small bean, filled with a fluid resembling pus, and similar to that found in the sac of the femoral artery. The sac was easily torn: its internal surface was ragged, and of a white colour, but seemed to be connected with the artery both at its upper and lower part: the origin of the anterior tibial artery was attached to the middle of its parietes. The coats of that vessel were so much thickened, that its canal was nearly obliterated. Below the sac the posterior tibial artery was filled with lymph for nearly two inches: the lymph adhered to the vessel, and terminated in a conical clot, where the peroneal artery is given off. The internal coat of both the inferior and superior portions of the artery were observed to terminate abruptly at the commencement of the sac. The plugs of lymph found in the four obliterated portions of the artery were observed to terminate opposite to the origin of branches from the trunk of the artery. The peroneal artery was in a natural state for a short space, but its coats suddenly became hard and thickened: its canal was almost closed. Beyond this point its internal surface was of a dark purple colour, and the coats of the vessel had lost their elasticity. The femoral vein adhered to the femoral artery opposite to the dilated

part of the latter. The coats of the vein in this situation were thickened, and its diameter somewhat diminished. Below this part its cavity was in several places filled with coagula of blood. The femoral artery above the first closure was healthy, as were also portions of the aorta which were examined. The brain was sound, having only a slight serous effusion on its surface. The abdomen was examined, but no diseased appearances were discovered. There was an effusion of about ten ounces of bloody serum in the left side of the thorax, and about half that quantity of pellucid serum in the right side. The lungs were healthy. The heart was of large dimensions, but its structure was natural.

During the continuance of the case, on account of its singularity, I requested my friends Mr. Newbigging and Dr. Gorden to visit Mr. H., and they obligingly several times accurately examined the appearances. Dr. Gorden was also kind enough to assist at the dissection.

Case of Popliteal Aneurism, in which a particular Mode of obliterating the Femoral Artery was successfully employed.

The following case, in which a new method of obliterating arteries for the cure of aneurisms was successfully adopted, is related by Professor Assalini of Milan*. The instrument employed for compressing

* See *Manuale di Chirurgia*, p. 81, Milan, 1812.

the artery resembles the pincers of M. Percy, which I have mentioned in a former part of this Treatise *. It consists of two short silver blades, connected together by a rivet, like a pair of common dressing forceps. The ends of the blades between which the artery was compressed, are broad and flattened. A spring, composed of a piece of elastic steel, is attached to the other end of one of the blades, and, by pressing against the opposite blade, retains the flat extremities of the instrument in contact. The degree of pressure is regulated by a screw, which passes through the handles of the instrument.

A man, fifty-one years of age, was afflicted with a popliteal aneurism, which, on the 2d of November, 1811, had arrived at considerable size. After compression had been tried for several days, the operation was performed by dividing the integuments covering the femoral vessels on the inside of the sartorious muscle. The femoral artery was fairly exposed, and placed between the blades of the compressor, without being raised from its bed. The action of the spring of the compressor, without employing the screw, was sufficient to stop the pulsation in the aneurism, but the jet of blood in the upper portion of the artery communicated to the instrument a very sensible oscillation. The sides of the wound were placed as near to each other as the intervention of the instrument, which was surrounded with lint, would permit. The patient was tranquil during the day and following night. Thirty-

* Page 208.

six hours after the operation a slight degree of fever had commenced. The pulse was frequent and hard, but the skin was moist, and the leg was in its natural state. At this time a very slight pulsation existed in the tumour. As it now appeared that the spring of the instrument was not of itself sufficient to resist the impulse of the circulating blood, and retain the sides of the artery in contact, the compression was increased by means of the screw which passed through the handles of the instrument. In this manner the circulation through the artery was totally intercepted. The patient did not complain of pain, or any inconvenience, except a sensation of cold at the ankle. Twenty-four hours after the instrument was tightened, no pulsation could be felt in the tumour, which had become soft, and was diminished one-third in size. Sixty hours after the instrument was tightened, it was conceived that the sides of the artery had united, and that the presence of the instrument in the wound was useless, and might occasion dangerous consequences. It was therefore decided first to unscrew, but not to remove the compressor, so that it might be tightened, if necessary. No pulsation, however, could be discovered in the aneurism when the compression upon the artery was omitted: the instrument was therefore withdrawn. Fourteen days after the operation the wound was healed, and in forty days the patient left the hospital, the tumour being reduced to the size of a small egg.

Professor Assalini informs me, that in two cases of popliteal aneurism in which he employed this

mode of obliterating the femoral artery since the occurrence of the above case, the instrument was removed at the expiration of twenty-four hours after it had been applied to the artery. The pulsation did not return in the aneurisms after the removal of the instrument, and the patients were cured in a very short time.

Case of Carotid Aneurism.

The following case is extracted from the New England Journal of Medicine and Surgery *.

" The distinguished surgeon, Dr. Post of New York, has lately performed the operation for an aneurism of the carotid artery, with success. The tumour was situated immediately below the angle of the jaw, was six inches long, and four broad. An incision was made between the tumour and the clavicle, three inches long. The muscles being dissected, and the sheath of the vessels opened, the artery was separated from the vein and par vagum. Two ligatures were passed under the artery three quarters of an inch apart, and being tied, the artery was divided between them. A needle was passed through the cut extremity of the lower portion, and a ligature made in the end of the vessel. As soon as the first ligature was applied, the pulsation in the tumour ceased. The patient suffered but little

* Vol. iii. p. 205. Published at Boston, April 1814.

the first day; afterwards he was attacked, like Mr. Cooper's first patient, with a violent cough. The ligatures came away in about eighteen days. The tumour gradually diminished. The healing process was retarded by the formation of a sinus in the neck, which was cured, and the patient discharged about four months after the operation."

Case of Axillary Aneurism in which the Subclavian Artery was tied.

I am indebted to Mr. Thomas Blizzard for the following notes of a case of axillary aneurism in which he recently tied the subclavian artery *.

The patient was a robust man, forty-seven years of age. When he was admitted into the London Hospital, on the 10th of January, 1815, a tumour as large as a small lemon was situated in the left axilla. It was surrounded with a diffused swelling, extending underneath the pectoral muscle upwards as high as the clavicle, and anteriorly almost to the sternum. The whole limb was swoln and œdematous. He complained not only of constant pain

* Since the preceding sheets of this Treatise were printed, Dr. Colles of Dublin has published an account of two cases of aneurism, in one of which he tied the subclavian artery on the tracheal side of the scaleni, and in the other on the acromial side of these muscles. Both cases terminated fatally. For a particular account of them I must refer the reader to Dr. Colles's paper in the 41st Number of the *Edinburgh Medical and Surgical Journal.*

in the tumour and the surrounding parts, but also of occasional attacks of the most excruciating pain in the palm of the hand. The integuments covering the tumour were of a dark livid colour: there was an appearance of excoriation, and a slight oozing of serum from its most prominent part. The skin upon the upper and inner part of the arm, to a considerable extent, was of an erysipelatous red colour. A distinct pulsation was perceptible at the base of the tumour, but it became less evident towards its apex, at which part it was altogether imperceptible. No pulsation could be felt in the radial artery of the diseased arm, the sensation of which was very much diminished. The pulse in the right arm was so quick that it was difficult to count it. There was but little difference in the temperature of the two arms. The breathing was hurried, and peculiarly irregular. The countenance was expressive of great anxiety, and he complained of extreme sufferings in his arm. On the 21st of December, 1814, whilst unloading a waggon, and having a heavy weight in his right hand, and his body supported by the other, he felt a sudden snap and an acute pain in his left axilla. Two days afterwards he observed a pulsating tumour in the axilla, the increase of which was attended with so much pain as to disorder his health, and render him unable to follow his employment as a labourer.

The subclavian artery was tied in the following manner, within half an hour after the patient was admitted into the hospital. An incision, about three inches in length, was made through the integuments

at the root of the neck, on the acromial side, and parallel with the external jugular vein. The platysma myoides being divided, the cellular membrane was separated with the finger, until the pulsation of the subclavian artery was felt where the vessel passes over the first rib. The finger being pressed upon this part of the artery, the cellular sheath investing it was carefully opened with the point of a knife. A ligature was then conveyed underneath the artery by a common aneurism-needle with the greatest facility. The ligature being tied in the common manner with a double knot, the wound was closed with strips of adhesive plaster. The omo-hyoideus muscle was not seen, and scarcely any blood was lost during the operation, which did not occupy more than five minutes.

Immediately that the ligature was tied the pulsation ceased in the tumour, which was also somewhat reduced in size. The swelling and tension of the surrounding parts diminished: the pain was very much abated, and the erysipelatous appearance on the arm was much less distinct. The limb was wrapped in wool and flannel: sixty drops of tincture of opium were given to him. In the evening his pulse was 108, and strong: his skin was moist: the temperature of the left arm was somewhat diminished: the opiate was repeated. On the morning of the first day after that on which the operation was performed, the pain was still more diminished: his respiration was more calm, though slightly hurried: the skin was moist: the temperature of the limb above the elbow was natural: below the

elbow and at the fingers it was much diminished: the diffused swelling below the clavicle continued to subside: no pulsation could be felt at the wrist: there was a slight oozing of a bloody fluid from the tumour: the pulse was 112, and strong. As there had been no evacuation from his bowels, a purgative medicine was given to him, and he appeared to be relieved by its operation. In the evening the opiate was repeated. On the second day he had more sensation in the arm, and felt a pricking in his fingers. The arm was as warm as the other to the touch, and perspired freely: the blood was observed to circulate naturally through its veins. The wound had adhered, and looked as well as possible. The swelling below the clavicle continued to decrease: a slight suppuration had commenced on the most prominent part of the aneurism. Pulse 104. In the evening he complained of pains in the hand and fingers, which he compared to the cramp. The ulceration upon the tumour was increased. Pulse 108. The opiate was repeated. He slept well, and was easy on the morning of the third day. The ulceration had extended, and a discharge of grumous bloody matter had taken place from the tumour, to which a resinous ointment was applied. The erisypelatous appearance on the arm was very much diminished, and the swelling below the clavicle continued to subside. His breathing was natural. Pulse 104. In the evening the discharge from the tumour was more copious: the cramp-like pains in the fingers continued. Fifty drops of tincture of opium were given to him. On the fourth day, when

he awoke in the morning, he was much alarmed by a very considerable discharge of grumous blood from the tumour. He appeared much agitated, but when the part was dressed he became more composed. He complained of languor and general uneasiness. Pulse 102, and weaker. His breathing was rather more hurried. He was troubled with a slight cough, by which the pain in the shoulder was increased. His tongue was white. As his bowels had not been evacuated since the operation of the purgative medicine, it was repeated. In the evening the medicine had operated, and the symptoms were much alleviated. A poultice was applied to the tumour, which was in a sloughing condition. The opiate was repeated. He passed a quiet night; but on the morning of the fifth day he complained of pain in the chest, which was increased by a full inspiration or by coughing. The sloughs were separating freely from the tumour. The swelling and hardness of the arm were much diminished, but the power of feeling and of motion was not increased. Pulse 100, and irregular. In the evening the pulse was 116: the skin warm and moist. The opiate was repeated. On the sixth day the breathing was still short. Pulse 120. In the course of the day occasional twitchings of the muscles, particularly of the hand and face, were observed. At intervals there was a slight confusion of intellect. In the evening his breathing was hurried. Pulse 128, but regular. The wound and the tumour continued in the same state. A slight lividity of the fore-arm and fingers was observed, which disappeared upon pressure, but returned

when the pressure was removed, except on the knuckles of the ring and middle fingers, where it was stationary. He was ordered some wine and porter: the opiate was repeated. He passed a very restless night, during which he was frequently delirious. On the morning of the seventh day the delirium continued, and his speech was very imperfect. The twitchings of the muscles were more general. He complained of great oppression, and frequently appeared drowsy. His breathing was short. Pulse 136, but not very irregular. His tongue was much parched. The limb was in the same condition as on the preceding day. In the evening a copious discharge of sloughs had taken place from the axilla. The swelling of the arm and shoulder had entirely subsided. The delirium and twitching of the muscles continued. Pulse 128, and weak. His breathing was very short. The wound above the clavicle had a favourable appearance. The allowance of wine was increased. The poultice was continued, and the opiate was repeated at bed-time. During the night he was very delirious. In the morning of the eighth day his pulse was 140, weak and irregular. His breathing was much hurried, and his countenance had a wild appearance. His tongue was parched, and covered with brown fur. His speech was so rapid as to be scarcely intelligible. The ring and middle fingers were black. The symptoms increased, and he lingered until night, when he died.

The following appearances were observed upon dissection. The wound above the clavicle contained

a very small quantity of pus. The ligature was situated on the subclavian artery, about one-third of an inch on the acromial side of the scaleni muscles. The external surface of the artery in the vicinity of the ligature was imbedded in lymph. The extremity of the artery on the acromial side of the ligature contained a conical plug of coagulated blood about the third of an inch in length. This plug terminated at the origin of a considerable branch. The extremity of the artery on the tracheal side of the ligature did not contain a plug of coagulated blood, but was closed by a clot of lymph of a white colour. The ring of the ligature was situated in a depression caused by the division of the internal and middle coats of the artery. The pericardium exhibited the effects of a high degree of inflammation. Its cavity contained about an ounce of serum. The heart and the reflected portion of the pericardium were covered with flakes of lymph. The posterior surface of the heart, when the lymph was scraped off, was of a deep red colour. The internal surface of the ascending aorta was of a bright scarlet colour. Its internal coat was much diseased, and exhibited numerous white patches. The internal surface of the right carotid and the left subclavian arteries was of a light red colour. This appearance, in a less degree, was also observed in the abdominal aorta. In the left axilla there was a large cavity, the boundaries of which were in a state of sphacelation. The sphacelation involved the aneurismal sac and the lower extremity of the artery communicating with it, the bra-

chial nerves, the veins, and adjacent parts. The upper extremity of the artery, and the commencement of the sac, were not destroyed. Both extremities of the artery, to a considerable distance, were filled with coagulated blood. Two of the fingers were completely mortified.

FINIS.

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ERRATA.

Page 22, line 10, *for* bears, *read* bear.
—— 28, — 23, — Arantii, —— Aurantii.
—— 140, — 7, — enacted, —— exacted.
—— 172, — 16, — inflammation, *read* irritation.
—— 181, — 27, *omit* " that."
—— 210, — 21, *for* Paupart, *read* Poupart.
—— 214, — 2, Ibid.
—— 217, — 29, *for* Medical and Chirurgical, *read* Medico-Chirurgical.
—— 220, — 19, — Œtius, *read* Ætius.
—— 241, — 28, — Medical and Chirurgical, *read* Medico-Chirurgical.
—— 249, — 21, Ibid.
—— 264, — 27, Ibid.
—— 334, — 3, *for* effected, *read* affected.
—— 335, — 12, — of, *read* or.
—— 419, — 31, *after* " authority," *insert* " that."
—— 506, — 23, *for* wound, *read* wounds.

Seaweed page 230

