On the diseases and injuries of arteries, with the operations required for their cure : being the substance of the lectures delivered in the theatre of the Royal College of Surgeons in the spring of MDCCCXXIX / by G.J. Guthrie.

ON

THE DISEASES AND INJURIES

OF

ARTERIES,

WITH

THE OPERATIONS REQUIRED FOR THEIR CURE;

BEING THE

SUBSTANCE OF THE LECTURES

DELIVERED

IN THE THEATRE OF THE ROYAL COLLEGE OF SURGEONS IN THE SPRING OF MDCCCXXIX.

BY

G. J. GUTHRIE, F.R.S.

PROFESSOR OF ANATOMY AND SURGERY TO THE ROYAL COLLEGE OF SURGEONS, SURGEON TO THE WESTMINSTER HOSPITAL, TO THE ROYAL WESTMINSTER OPHTHALMIC HOSPITAL, *&c. &c. &c.*

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TO THE

PRESIDENT, VICE-PRESIDENTS,

AND COUNCIL,

OF THE

ROYAL COLLEGE OF SURGEONS IN LONDON,

This Work

IS RESPECTFULLY DEDICATED,

By

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PREFACE.

My object in the first part of the following work, is to demonstrate the value and importance of that portion of the pathological collection in the museum of the Royal College of Surgeons, which relates to the subject of Aneurism; and to prove, that the labours and researches of Mr. Hunter anticipated nearly all the observations which have been made by his contemporaries and successors.

I have entered more fully in the subsequent part into the consideration of the nature and treatment of Wounds of Arteries, illustrating these points principally by observations and cases which occurred during the late war in Portugal, Spain, France, and the Netherlands; and I would fain hope it will give to this part of surgery a

precision which it has not hitherto universally attained. I have endeavoured to be as concise as possible, compatible with clearness of expression, and have avoided, as far as lay in my power, quotations and references, which would have made a book, already larger than I expected, of twice its present size.

The matter contained in this part has been many years announced as preparing for the press; and although it has not been published, it has been annually promulgated in my surgical lectures for the last fourteen years; and if any practical information which it may contain has been delayed, it has certainly not been withheld.

2, Berkeley Street, Berkeley Square,
April 24, 1830.

ADVERTISEMENT.

THE first of the following cases was published in the American Journal of the Medical Sciences, for February last, and did not reach England until after the observations on the subject to which it relates were printed, from page 167 to 208. The second and third cases I had mislaid, and only recovered them in time for their present place. Like all the others, they are much abridged.

Case by Dr. Mott, of New York.

"Moses R. Gardner, ætat. 51, by profession a farmer, of sound constitution and good habits of life, applied to me some time in March for advice. Upon examination, I found above the sternum a pulsating tumour, about the size of a pigeon's egg, spreading some distance under the clavicular and sternal portions of the right sterno-mastoideus muscle, in the course of the subclavian artery, and extending as low down upon the pleura as the second rib, compressing more or less the bronchial tubes, and producing, on the least coughing or exercise, a wheezing, not unlike that of asthma. He shrank from the least pressure upon it, complaining of impeded respiration, followed by pain.

Its pulsations were synchronous with those of the heart, and decidedly aneurismal.

"On the 12th of September he again came to the city. I found the tumour above the sternum had increased to the size of a large walnut, and upon a careful application of the stethoscope, it was evidently encroaching more upon the chest. The whizzing sound *(bruit de soufflet)* could be heard; the thoracic viscera were sound, the respiratory murmur being distinct throughout. His respiration was very much impeded by speaking, walking, or coughing, and almost entirely suspended by the least pressure upon the tumour. The action of the right carotid was much more feeble than that of the left; no pulsation could be discovered in its branches. The right subclavian, external to the scaleni muscles, was natural, while the axillary and brachial arteries could hardly be felt. At the wrist no pulse could be found. The pulsations of the arteries of the left side were natural. His general health was good. On the 26th of September I operated. The artery was taken up in the usual manner: no material change was observed.

"27th, 9 A. M. Slept well, and feels refreshed; thinks there is more room, as he expresses it, in breathing; complains of a little soreness of the tonsils in swallowing; pulse 58, regular and tranquil; skin natural; pulsation and size of the tumour evidently diminished. 9 P. M. Much more restless from mental alarm; pulse 68, tense; in other respects the same as in the morning. Being habituated to laudanum, was permitted to take a teaspoonful.

"28th, 9 A. M. Slept well after the opiate; breathes

easily, and says he takes "a more satisfactory breath" than he did before the operation; feels much less of the pulsation in the tumour; pulse 63, not so tense; skin natural; cough much less. Ordered a dose of calcined magnesia and Epsom salts. 9 P. M. Has passed a comfortable day. His wife, who arrived from the country since the morning, expressed her surprise at the improvement in his voice and breathing, and the difference in the beating of the tumour. Pulse of the right radial artery very distinct, but intermitting once from ten to fifteen beats; in the left arm 80; coughs frequently, and expectorates freely; skin natural; tongue a little white; salts have not operated. Ordered the dose to be repeated, and if restless after its operation, to take his usual anodyne.

"29th. Saluted me this morning upon entering his room with a full and fine voice, and said he was well enough to call on me. Salts operated freely; thinks his cough and expectoration much less. I found him lying down and breathing quietly; pulse 71, and regular; the radial artery of the right arm beating as last evening, with fewer intermissions but of longer continuance; skin over the tumour more wrinkled; pulsation appears less, and feels weaker. Directed to continue his tea, toast, and gruel. 8 o'clock. As well as in the morning; takes a full breath without the least wheezing; pulsation in the right wrist very distinct and regular; in the left, 62 to the minute. Continue the opiate.

"30th. Found him lying more recumbent than at any former period; pulse 70, and regular; right radial artery does not beat quite so firm as yesterday; wound

discharging a little, was dressed. October 2. Says he now feels as if he would get well; cough rather more troublesome; pulse 57; pulsation of the right radial the same; his bowels not being free, directed sub. mur. hydr. grs. viij; sup. tart. potassæ, pulv. jalapa, āā ℈ j: m. Evening. Medicine has not operated; directed a dose of sulphate of magnesia. 3d. Cough and bronchial effusion very much diminished by the operation of the cathartic; pulse 68. 4th. Feels very well; passed a good night; all his symptoms improved; pulse 74; can bear any degree of pressure upon the tumour without the least pain or difficulty of breathing. 10th. Continues to mend, and is sanguine as to his recovery; pulsation of the tumour hardly perceptible, and to the touch very much diminished; cough less troublesome; left pulse 66; right very feeble. 16th. Ligature separated and came away last night; the tumour above the sternum, and pulsation entirely disappeared; cough and breathing better; voice nearly natural; pulse 66; now and then a very faint pulsation of the right radial artery; right hand a little swelled and feels numb, and complains of want of power to close it. 22d. Wound just healed; weakness of the arm very considerable; fingers very thick and clumsy; arm swelled, and pits upon pressure; no pulse in the right radial artery; breathing very easy; cough and expectoration much less; can sleep easy in any posture, which he has not been able to do for many months. 26th. Left town this morning for his residence in New Jersey."

Time is required to demonstrate the permanency of the cure in this case, which will in all probability

take the same course as that under the care of Mr. Evans, page 174.

Alexander M'Donald, of the twenty-eighth regiment, 28 years of age, was admitted into Hilsea Depôt Hospital on the 1st of July 1816, for a gangrenous spot on the great toe of the right foot, which soon got well. Twelve days after his admission, a pulsating tumour was observed in the ham of the same side. On the 7th of August the tumour was of the size of an egg, and the arterial action strong in every part of the body. Pulse 100, occasionally intermitting, and having a peculiar hardness. He says he was wounded in 1814 by a musket-ball in the same thigh, the cicatrix of which is directly over the femoral artery, about its middle; but he was not long confined by it, and has ever since done his duty as a soldier. He complains of an oppression in the region of the heart, which seems as if it would sometimes suffocate him, more particularly at night, when he is obliged to sit up in the erect position. On the 16th of November he died suddenly in one of these fits of suffocation. On opening the body, the lungs were found in a healthy state. The pericardium contained sixteen ounces of fluid. The right auricle and ventricle were distended with blood, but sound in texture. The left auricle was nearly empty. The left ventricle was considerably enlarged, and the walls much thickened. The semilunar valves were ossified.

The right femoral artery, or of the diseased side, was larger than that of the left. The aneurism was situated exactly at the spot where the popliteal artery

divides into the posterior and anterior tibial arteries, and was of the size of a walnut. The posterior tibial opened directly into the sac. The orifice of the anterior tibial artery, which had originally opened into the sac, was closed, as well as about three-eighths of an inch of the vessel. Within the space of six inches above the aneurismal sac, the artery gave off fourteen branches in pairs, larger than those in the opposite limb, which were only seven in number. On a careful examination of the sac, nothing in the shape of a rupture of its coats could be discovered; but the dilatation of the coats of the vessel was evident and satisfactory to all present. The abdominal viscera were sound.

In this case, the obliteration of one vessel had no influence on the tumour, although the passage of blood through it was diminished by two-fifths.

The following is a case of aneurism of the arteria tibialis postica, by staff-surgeon Roche, at Tarragona, in the year 1813.

"John Sullivan, private, twenty-seventh regiment, was received into general hospital with a compound dislocation and fracture of the ankle joint. His leg was amputated without delay, about six inches below the knee. Nothing unusual marked the case, till three days after, when I was informed that hemorrhage had taken place. On inspection I discovered an aneurism of the tibialis postica, about the size of a pigeon's egg, situated about an inch above the ligature that had been attached to that artery. I inferred, that an unusual influx of blood, with the opposition which the ligature had

given to the usual course of the circulation, had conspired to rupture the sac. I had an option of three modes of proceeding.

"To amputate above the knee—operate on the thigh for aneurism—or tie the artery close to its branching from the poplitea. Many reasons induced me to prefer the last. Even should it fail, I had the former resources in reserve. I proceeded therefore to expose the artery, and to pass a ligature midway above the sac and the termination of the poplitea. Using the crooked needle, I surrounded the artery, necessarily including some of the soft parts. The stump was then dressed, and the state of the circulation most carefully attended to; and although inflammation and some sloughing succeeded, the ligature answered well, and came away in twelve days. The sac was absorbed, and now, about a month since the operation, the cure is nearly complete. Perhaps I was in some degree aided in this result by the application of a splint fixed under the knee joint, so as to keep it extended with as little inconvenience as possible to the patient.

"On inquiry I learned, that previously to his entering the service he had been constantly on horseback. He had often felt pain and uneasiness in the parts, which were considered rheumatic. There was no external appearance indicating disease, and I was encouraged to hope for a successful issue, because no symptoms showed arterial derangement above the knee."

In this case it would appear that the ligature of the artery below the aneurism led to its rupture.

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DISEASES AND INJURIES OF ARTERIES,

&c. &c.

An Artery, although essentially composed of the same materials in every part of the body, differs in its structure, according to its size, situation, and the particular use to which it is occasionally applied. It admits of considerable change in its dimensions, which is accompanied by a corresponding augmentation or diminution of substance, bearing in general a direct proportion to the action required of it; whilst the materials relatively entering into its composition undergo a similar alteration. An artery may be divided by minute dissection and maceration into many layers, at the pleasure of the anatomist. It is separated readily into three, the internal, middle, and external coats.

The *internal coat*, is in the aorta composed of several layers. In the extremities it is a single membrane, of a smooth or polished appearance, of a whitish

yellow colour, partly transparent, without fibres, soft and unctuous to the touch, of a dense elastic resisting membranous structure, although by a slight degree of extension readily torn in every direction. Neither vessels nor nerves can be traced into it in its natural state, although their existence is proved by its capability of undergoing the various processes dependent on inflammation. It is sometimes seen in the carotid and iliac arteries, disposed in longitudinal plaits, as if folded, instead of having contracted on the diminution of size of the artery. In the ham, and at the elbow, these little folds or ridges are placed transversely; and in an artery torn or divided during life, this appearance is always observable, and it performs probably an important part in the suppression of hemorrhage.

The *middle coat* adheres intimately to the internal coat, and is composed of circular flattened fibres disposed in layers, and united to each other laterally by smaller ones passing obliquely between them. The circular fibres do not extend completely round the artery, they rarely indeed form more than half a circle; and are conjectured to be the seat of its contractile, the oblique ones of its elastic properties. It is more natural to suppose they are common to both, although acting in different directions with various degrees of power; the enlargement or diminution of an artery being comparatively greater than its extension. The circular fibres are easily separated from each other by dividing the oblique ones, and the whole forms a strong, dense, elastic although brittle coat of a yellowish white colour, thicker than the remaining

tunics conjointly. In the aorta it is very thick and may be separated into several layers, which diminish in number as the artery passes to the extremities; where it seems to form one fibrous expansion, stronger perhaps in proportion to the size of the vessel than in the aorta itself. This fibrous structure is said to extend even to the most minute vessels, although it is not easily demonstrated. In the arteries of the brain it is exceedingly thin, so much so, that its existence has been denied. It is through this coat the artery preserves the nearly circular appearance which it presents when divided in the dead body: it is therefore highly elastic as well as contractile, both longitudinally and transversely. No longitudinal fibres can be discovered, although their existence has been asserted, and it is possible that the folds seen in the inner membrane may have given rise to this supposition.

The *external coat* is composed of a substance essentially distinct from the other two. Cellular and fibrous, the fibres interlacing with each other, without any marked regularity, although generally tending in a diagonal direction. It is capable of a powerful resistance to an opposing force applied in every way, and although highly elastic, seems to partake of a ligamentous structure. It is to this that an artery is indebted for its capability of sliding out of the way of injury; it suffers and resists a considerable degree of violence with impunity; and whilst the other coats are divided by the application of a small ligature, it remains unhurt, until inflammation occurs from pressure. If an artery be forcibly distended by an

injection, the two inner coats are ruptured, but the external one is at first only stretched and dilated but not torn, forming a kind of aneurismal sac. The external coat may be divided by the knife into two layers apparently different; the inner layer, which is applied to the middle coat, is smooth and dense, differing from the external one in being more membranous, and not having its fibres obviously interlacing with each other as in the outer coat, although intimately connected with it. The external coat, particularly in the larger arteries, is surrounded by a layer of cellular tissue, attaching it loosely to a denser cellular structure called its *sheath*, which connects the arteries with the accompanying vessels and nerves, and separates it more or less from the surrounding parts. This sheath keeps the artery steadily in its place, although it admits of considerable motion within it, more particularly on the division of the artery, when its retraction within the sheath is often observable to a considerable extent. In the chest, the arteries are at first partly surrounded by the internal and serous membrane of the pericardium, and afterwards by the pleura; in the abdomen by the peritoneum. In all other parts the sheath is formed of cellular texture. In the upper part of the thigh, the fascia transversalis descending under Poupart's ligament constitutes its outer covering.

The coats of the arteries are supplied with blood from neighbouring vessels, which send small branches into them, denominated *vasa vasorum*. In the trunk, the nerves are derived from the great sympathetic and pneumogastric; and branches from the sympathetic are continued into the arteries of the extremities, but

these are also supplied by nerves from the spinal marrow, called in distinction central and spinal nerves.

Viewing the different arteries of the human body, with relation to their structure, it may be presumed *a priori* that the larger ones possess more elasticity, the smaller ones more contractile power; an opinion which will be found to accord with the facts observed in practice.

This capability for contraction, on the application of certain stimuli, gave rise to the opinion of arteries being muscular, but which has been disputed on account of their not being found by chemical analysis to possess the same component parts, and particularly the same quantity of fibrin, as muscles. The terms contractility, retractility, tonicity, &c. have therefore been preferred to that of muscularity. It is however a mere difference about a name; no one in the present day doubting or disputing the fact of the capability of an artery to alter its dimensions through the agency of a power distinct from elasticity, and which may with propriety be termed contractility. It would indeed be taking a very limited view of nature, to suppose that every thing possessing contractile powers must be muscular, because we know that a muscle contracts.

An artery of the size of the femoral is found after death, when entire, to be a tube of a flattened circular form, the canal of which is maintained by the elasticity of the middle coat of the vessel; and when cut across several times within the space of two or three inches, where no branches are given off, presents an orifice of a similar diameter. The permeability of an artery during life, is supposed to depend on the conti-

nuity of its elastic structure, which is thus capable after death of preventing its sides from falling together. If this continuity of the elastic structure be destroyed during life by dividing the artery, it retracts or diminishes its length, provided it be not included in bone; and the orifice or cut extremity contracts and diminishes in size in proportion to the dimensions of the artery; and this diminution in small arteries goes on, until with a little assistance from the blood the opening becomes closed. A power is here shown to exist in the artery during life, which it does not possess after death, and is therefore said to be dependent on life, and different from that elasticity which is only destroyed by decomposition. When a limb has been cut off during life, and is examined a few hours afterwards, the orifice of the artery formed by the amputating knife will be found much smaller, in other words more contracted, than the next portion of the artery immediately below it. This contraction of the orifice will require to be removed by dilatation, when it will not again contract; or this dilatation will gradually take place with time, as the period of decomposition approaches. The division of an artery some time after death is not followed by this contraction of the orifice, or cut part, and therefore the existence of a contractile power dependent on life, and distinct from elasticity, is proved.

Mr. Hunter stretched a portion of the carotid artery longitudinally, and then allowed it to retract, which it did to the same length as before the stretching, that is, it returned to its proper length by its elasticity. But when another portion of the same

artery was stretched transversely, and allowed to retract, it did not recover itself by two-thirds, that is $\frac{6}{12}$ became $\frac{10}{12}$, which addition he considered to depend on lost muscularity, or contractility. When a solution of the continuity of a living artery takes place, the first effects are retraction and contraction, as dependent on elasticity and contractility. When an artery is exposed, and subjected to the application of stimuli, it shows that it is capable of diminishing its size, and under certain circumstances even of enlarging, to a considerable extent. The experiments of many persons place this beyond all doubt; and it has never been disputed, that when a great change in the animal economy is undertaken by nature, such as the growth of horns in deer, the enlargement of the uterus in pregnancy, &c., or when inflammation occurs, the vessels leading to the part become increased in size, and when the duty required of them has been performed, again diminish to their previous state. A small artery by a power residing within itself can diminish its size until the canal becomes impervious; an artery of the size of the tibial may be forced to contract in a similar manner, by the application of stimuli which do not corrugate or injure its texture; but an artery of the size of the femoral cannot contract or be made to contract, so as to render its canal impervious, by any applications which do not injure its texture—facts of the greatest importance in the consideration of the means adopted by nature or induced by art in the suppression of hemorrhage.

A large artery may be considered as a tube, capable

of enlargement and of diminution, but not of being rendered impervious, except by disease, under the usual and common circumstances of life. A small artery is equally a tube, liable under the ordinary circumstances of life to great interruption, often to temporary stoppage, and frequently to obliteration. The blood is propelled into these tubes by the action of the heart, and the force exerted by this organ has been estimated in a variety of ways and by many persons, so as to lead to very erroneous practical deductions and results. It has been supposed by Borelli to be equal to that which would raise one hundred and eighty thousand pounds. Hales reduced this to fifty-one pounds five ounces, Keil to eight ounces, and Dr. Arnott, the latest calculator on this subject, makes it sixty pounds. From these calculations it was inferred, by Mr. J. Bell and others, that the force with which the blood was propelled was so great as to be irresistible, and that no compression could be made on a large artery sufficient to stop the flow of blood through it—an error which was exposed and refuted in my work on Gun Shot Wounds, in 1815, and to which it will be necessary hereafter to advert. The power of the heart, whatever it may be able to raise in weight, is so trifling as to the force required to oppose it effectually, as to be very difficult of calculation. If the axillary artery be divided in the human subject, all that is required to prevent hemorrhage, is to place the end of the fore finger accurately over the mouth or orifice of the vessel, and to retain it there with the least possible effort. I have made the experiment at least twenty times on man, and always with success, which induces

me to consider the power of the heart as very trifling; being, in fact, only sufficient to propel the blood through open tubes possessing life, and certain indefinable powers which also influence its motion. That these indefinable powers reside principally in the capillaries appears to admit of little doubt, and when these are better understood, a more correct theory of the circulation of the blood may be established than we at present possess. The arteries of the human body examined during life, in every part capable of inspection, show no sign of alternate regular diminution and enlargement. The only observable motion is that of elongation and elevation, which is in fact that of the pulse. When the artery is pressed so as to diminish its canal, the sensation of a fluid passing through it can be felt, and this it is which gave rise to the idea of an alternate contraction and dilatation, which do not exist. An artery appears during life to be larger than it is after death, even when moderately injected. I have conceived that the arteries contain air in an uncombined state, which may assist in keeping them distended, and in facilitating the circulation; but I have not been able to prove it.

Of the Alterations of Structure in Arteries.

Arteries are capable from their texture of undergoing the various processes dependent on inflammation; but by a wise provision of nature, without which the life of man would be continually in danger, they are not prone to suffer from it spontaneously. They are indeed rarely affected by it in the acute form, and then generally in consequence of injury, or by the

extension of disease from continuity of parts. An artery will frequently be observed at the bottom of a large wound pulsating regularly, and continuing to exercise its proper functions, whilst all the surrounding parts are in a state of suppurative inflammation. It will sometimes even be seen stretched across a cavity formed by ulceration, surrounded and thickened by a quantity of lymph thrown out on its surface, yet retaining its functions. The inflammatory action has only extended to the cellular texture surrounding it, and to its outer coat, without implicating those within, and the canal only becomes obstructed when these partake of the inflammatory action. The three different structures forming the separable layers or coats of an artery, are not only intended for the due performance of the function of the artery, but constitute, by diversity of texture, a barrier to the progress of inflammation. When this in its acute form has extended to them all, obliteration of the cavity, ulceration, sloughing, gangrene, and mortification are the results, according to the nature and extent of the inflammation.

The acute attacks of inflammation which affect arteries are of two kinds, phlegmonous and erysipelatous, a distinction I first made in regard to veins, and which is of the greatest importance as a pathological fact, death being the invariable attendant on the erysipelatous inflammation, whether it take place in arteries or veins.

The first effect of acute phlegmonous inflammation from injury, is to render the outer surface of the artery affected by it more vascular, and to give to its internal

coat a blush of redness, not observable in its healthy state. This is soon followed, as in all serous membranes, of which nature the internal coat of an artery partakes, by an exudation of lymph, which adheres in the first instance to the sides of the vessel, but gradually increasing, fills up the canal, and completely obstructs the passage of the blood through it. The external and middle coats of the artery become thicker and redder, and consequently more vascular; the redness being more observable when the inflammation is from external injury, the vasa vasorum being then larger and more distinct. The middle coat becomes softer, and its fibres are more readily torn, or rather broken down by a ligature than in a state of health. The redness of the inner coat is certainly caused by vessels, although they cannot be satisfactorily demonstrated. The inflammation being truly phlegmonous, neither extends far upwards nor downwards, but is confined to the immediate vicinity of the part affected, and ceases by the effusion of lymph to which the blood in its coagulation adheres. This is never removed so as to render the canal pervious; on the contrary, the absorption which takes place is accompanied by a gradual diminution of the vessel, until it is reduced to the state of a ligamentous cord; the system generally during this process being but slightly, or not very perceptibly affected.

When the acute inflammation is idiopathic, or not dependent on a direct injury to the artery, it is usually confined to the aorta and vessels in the immediate neighbourhood of the heart; and generally in conjunction with other disease, rendering the diagnosis doubtful. On examination after death of those cases in

which it was supposed to exist, the aorta is usually found of a red colour, varying from the scarlet of phlegmon to a deeper tint of poppy and of violet red; the inner membrane has at the same time lost in a considerable degree its shining or smooth appearance, is softer, and when scraped by the scalpel or nail, is easily detached from the middle tunic, from which in the healthy state it is with difficulty separated. The middle coat is much softer than natural, is more easily torn, and is separated from the external coat with a facility quite unusual in a healthy state. A thickened or swelled and red appearance of the coats of the artery, is in addition to these signs of disease quite decisive of its nature; and on the confines of the inflammation, the injected state of the vasa vasorum may be often observed with greater facility than in the centre of the part most implicated by it, whilst the presence of coagulable lymph or fibrin within, or of an albuminous secretion adhering to the inner coat of the vessel, leaves no room to doubt of the kind of inflammation which has taken place in the aorta. The matter secreted from the false membrane thus formed is usually washed away by the current of blood, until the force of the heart becomes impaired, when the blood will coagulate, forming polypous concretions, the nature of which and the time of their existence before death has been disputed. In smaller arteries, the red matter of the coagulum which fills the vessel is often removed, and vessels have been seen in the centre of it indicative of commencing organization. In other cases the canal of the artery has been found to contain pus, mixed with coagulable lymph, &c., which if the patient had lived must have been absorbed, or discharged by the

formation of an abscess, a consequence of inflammation of arteries of which I have not seen an instance, although it frequently occurs in veins. Pus is often found in the umbilical artery of infants, and, with the inflammation which gave rise to it, appears to be a frequent cause of death. Inflammation of the great arteries, and particularly of the aorta, is seldom so well marked as is thus described, and they are subjected to a redness of a somewhat different character, the nature of which has been disputed. It has been considered by some pathological anatomists as dependent on inflammation, by others on imbibition, when the sufferer has been long in the agonies of death, or indeed after death has taken place, and putrefaction has commenced.

The redness from imbibition varies from the scarlet to the brown or violet colour, is not accompanied by swelling or turgescence of the coats of the artery; and unless other disease is manifestly present, the internal coat cannot be separated from the middle one, but with great difficulty. The tint of redness in imbibition is the same throughout the coats of the artery when all are affected, which is not quite the case in inflammation. The redness often terminates abruptly, is deeper coloured in some parts than in others, more particularly where that part of the artery has been evidently in contact with blood more or less coagulated; the under part of the artery, when it is not full, is therefore most coloured, and some spots or stripes are occasionally found of a deep red, whilst the surrounding parts are of their natural appearance. This state of artery may be produced after death, by

filling a portion of it with blood taken from the same subject, provided it be nearly fluid, and placing it in the stomach or other internal part, for twenty-four, forty-eight, or sixty hours, whilst decomposition is slowly going on. On examination at the end of these periods, the internal coat of the artery will be found to have taken on the colours described. The scarlet tint may be produced in twenty-four hours, the darker colour is more obvious if the experiment be continued longer, if the coats of the arteries be soft and moist, the blood fluid, and decomposition going on quickly. Exposure to the air of the inner coat of an artery which has been slit open, is sufficient to give it a red colour of a somewhat similar description.

Laennec, to whom we are indebted for the experiments which established these facts, was induced to conclude from them, that this particular kind of redness was dependent on imbibition, and not on inflammation; and took place in persons who were long in dying, in whom changes had begun to take place in the blood before death, which prevented its coagulation, and in whom decomposition rapidly supervened. That it was a change in the vessels not dependent on disease, and ought not to be considered as an effect of inflammation, unless accompanied by other more positive signs; an opinion which the observations and discoveries of Dutrochet*, and the later experiments of Bouillaud and Andral confirm.

This tinting of the arteries from imbibition is frequently found in persons who have died of putrid

* Dutrochet, Nouvelles Recherches sur l'Endosmose et l'Exosmose, &c. &c.—Paris, 1828.

fevers, and was even supposed to give rise to a particular kind of fever, but it is also seen in consumptive persons who were long in dying, and in others whose blood did not coagulate. It is not accompanied, or has not been observed to be accompanied by any particular symptom from which the presence of such an alteration might be suspected. The symptoms of inflammation of the great arteries are very obscure, and the disease itself is one of infrequent occurrence. When its previous existence in the aorta has been proved by examination after death, the principal symptoms which have been observed during life were, a strong full-bounding or vibrating pulse, attended by a particular throbbing of the arteries of the head and of the aorta itself, together with a painful sensation at the heart and in the course of the aorta, accompanied by indescribable feelings of anxiety and distress; symptoms, in fact, which are more or less observed in every case of pure inflammatory fever, the synocha of Cullen. The increase of, or a greater degree of throbbing and pulsation in the aorta or artery affected, has been considered as a sign nearly characteristic of the seat of this inflammation; but unless we are prepared to concede, that the internal membrane of the radial artery is in a state of acute inflammation in every severe case of whitlow, we cannot admit a special increase of pulsation in any particular artery to be a conclusive sign of inflammation of that vessel. I have seen every artery in the body that could be observed, bounding and vibrating in such a manner in a patient who had femoral aneurism, as actually to raise the bed clothes when they were loosely applied to any surface immediately over them. The late Mr. Todd of Dublin,

mentioned to me that he had had a similar case under his care, in a patient who suffered from popliteal aneurism, that he had performed the usual operation, and cured by it both the aneurism and the deranged action of the heart and arteries. This statement induced Mr. White, who was present, to place a ligature on the external iliac artery of the patient to whom I have alluded, who was in the Westminster Hospital. It cured the aneurism, but had no influence on the increased action of the arteries. This man lived one year afterwards in the same state, and died in consequence of the rupture of an aneurism of the abdominal aorta. This proves at least that these symptoms did not depend on acute inflammation of the arterial tunics; and from the consideration of this and other cases I am led to believe, that the great and irregular action of the arteries depends, in such circumstances, on irritation rather than on inflammation of their internal membrane. The other symptoms are certainly not alone dependent on it, and the opinion of Frank, formed from the appearance of the internal membrane of the aorta after death, that these symptoms indicated inflammation of that part, of which the fever was only symptomatic, has received little support from contemporary or later authors, even if the observation of Laennec and others on these appearances have not completely refuted it. Acute idiopathic phlegmonous inflammation of the internal membrane of arteries, occurring alone, is so rare a disease, that sufficient observations have not been made to enable us to distinguish its pathognomonic symptoms, and when occurring with other complaints, is so obscured by them, as not to be sufficiently pro-

minent to attract observation. It is however admitted by the strongest advocates for an increase of pulsation in acute inflammation of the arteries, that in cases in which the preternaturally increased pulsation of the aorta was most distinctly present, no trace of inflammation has been discoverable after death.

The following case is highly important. It confirms the view I have taken of the cause of the increased action of the arterial system; and shows the error committed in not performing the operation at an early period, by which the life of the man would in all probability have been saved. The preparation is 387, C.

J. P. a stout middle-sized man, aged 53, felt a severe pain in his right shoulder in November, when making a great exertion in lifting a weight; and, on putting his hand to the part, discovered a small hard pulsating swelling under the collar bone. He was admitted into one of the London hospitals in January, when his disease was pronounced to be aneurism of the subclavian artery becoming axillary, the tumour being immediately below the clavicle. The action of the heart and arteries appeared to be greatly increased; and on examination the pulsations of the opposite subclavian or axillary artery appeared to be so much augmented, and to elevate the parts external to it to such an extent, as to lead to the belief that this vessel also was dilated. Under this impression the man was not strongly urged to submit to an operation, which he had previously declined; and he remained in the hospital, the aneurism gradually increasing until the month of August, when he went into the country. In December he came for the first time under my observa-

tion, and now declared himself willing to submit to any operation which might be proposed. Life he said was a burthen, from the continued pain and numbness he experienced in the shoulder, chest, and arm of the affected side; and from the teazing of a cough and expectoration with which he was tormented. The tumour was now as large as a forty-eight pound shot, pulsated strongly, and with a peculiar thrill at the upper part. The clavicle was pushed upwards, so that compression on the artery on the outside of the scalenus anticus, did not effectually command the flow of blood through it, or diminish the pulsation. The artery below the tumour was infinitely less powerful in its beat than that of the opposite side. The expectoration was of a purulent nature. Having been informed of the idea entertained of the state of the left subclavian artery, I examined it minutely, both by the fingers and stethoscope, and came to the conclusion that it was not enlarged, although its action was considerably increased. There seemed to be no objection to the operation being performed, or at least attempted, on either one side or the other of the scalenus, except the state of the chest; which appeared likely to render any operation unavailing, however successfully done. In a few days after my examination he began to spit blood, which gradually increased in quantity until his death, which occurred within three weeks.

On opening the body it was found that the aneurism had forced its way into the right cavity of the thorax by the removal of part of the first five ribs, had become united to the upper lobe of the lung, and had

finally opened into it, so that the gradual discharge of blood killed the patient.

The arch of the aorta was dilated preternaturally, but did not contain any blood; the right subclavian, or the diseased one, was sound for half an inch after it passed the outer edge of the scalenus anticus muscle, when it became slightly dilated, and the aneurism commenced, apparently by dilatation. It soon formed an oval opening, an inch and a half in extent, the edges of which were rounded off, but the inner coat was traceable a little way over them. The left subclavian was of its natural size; but the aorta and it, and part of the right subclavian, had atheromatous patches in various places. The brachial artery below the tumour was smaller than natural. The veins in the right axilla were inflamed, plugged up with lymph and coagula adhering to their sides. In some places they were ulcerated through, and communicated with small abscesses external to them. The size of the aneurism had caused the artery to be pushed upwards with the clavicle, so that on making an incision along the upper edge of that bone, the lowest nerve of the axillary plexus presented itself; the artery was not below, but immediately behind it, and the first rib could not be felt by passing the finger downwards along the edge of the scalenus, because it had been absorbed through the pressure of the sac. The scalenus was slightly attached to a small portion of the anterior extremity of the rib, which remained in connection with the sternum, washed by the blood of the aneurism, the sac of which was at this part extremely thin. There

would have been no increased difficulty during life in placing a ligature on the artery, on either side of the scalenus, because its pulsation would have directed the surgeon to it, even in its altered situation.

The symptoms by which inflammation of the aorta may be known have not yet been discovered, although they may be suspected; and an accurate diagnosis of that disease is still a desideratum. I cannot agree in the opinion, that acute inflammation may exist without leaving any mark after death. It is true that the aorta is never obliterated by the effusion of lymph, as a smaller artery invariably is under similar circumstances; and it is possible that the force of the circulation and the size of the vessel may prevent it; but if there were inflammation to any extent, some remains of a false membrane would be seen, although its secretion might be removed.

The erysipelatous inflammation of arteries has not been described as an idiopathic disease, and I have never seen it as such; but I believe the inflammation, which succeeds to an injury, and spreads along the internal coat of an artery until it reaches the heart, to be of that nature, and a most fatal disease. I have only verified its existence by dissection in three instances; and in all, the patients died very quickly after the accession of the symptoms: but others have noticed in their post mortem examinations, inflammation extending from the spot where a ligature has been applied up to the heart, and in these cases death was preceded by symptoms of low and irritable fever.

I have alluded to one case of this kind in my work

on Gun-shot Wounds, page 96, third edition. The patient died suddenly and unexpectedly, the limb was greatly swelled and gorged with blood, the femoral artery, when opened, appeared more vascular than is commonly observed, its internal membrane was very red, and easily separated from the middle coat, and the fluid which lubricated its surface was of a more serous nature than usual, and greater in quantity. The other two cases I did not see until death was impending. In each, the right leg and thigh were greatly swelled and œdematous, the skin was of a pale dead white colour; the countenance was extremely anxious and bedewed with sweat; the pulse 140 and weak; the patient sensible, and expressing hopes of recovery. In both cases the arteries showed the same character of disease, which extended upwards as high as the diaphragm. I gave a portion of the femoral artery taken from one of these cases of disease to Mr. Brookes, who considered it to be one of the finest specimens of arteritis he had ever seen. The symptoms which mark this state of disease, when distinguishable, and several cases are recorded where the appearances described have been noted, are a very quick pulse, a rapid deterioration of the state of the patient, and degeneration into irritative fever, with low delirium, followed by death.

In the three instances which I have mentioned, the erysipelatous inflammation of the arteries was evidently caused by continuity of parts with those already inflamed; and in all of them the inflammation was a deep-seated disease, situated in the muscles and

internal structure of the thigh, the skin being apparently unaffected.

Chronic irritation or inflammation, by which a slow change in the structure of a part is usually accomplished, appears to be the cause of the various alterations which are found in arteries. The first and simplest change is a loss of the elasticity natural to them, which may lead to a state of dilatation, without abrasion or rupture of any of the component parts of the artery, although sometimes accompanied by a general diminution of substance, and particularly of the middle coat. The cause which gives rise to the loss of elasticity seems however also capable of exciting in the artery a sort of preservative action by which it may be strengthened. The loss of elasticity is therefore more usually accompanied by changes which are very obvious; such as softening of the inner membranes, partial or general irregular thickenings, or depositions of cartilaginous, calcareous, or other matters, between the coats of the vessel. It is well known that irritation may give rise to alterations of structure of very different kinds; to the thickening of a part, to its partial removal by progressive absorption or thinning, and to its total removal by ulceration.

A whitish or yellowish exudation is usually the first observable change, which afterwards becomes a patch projecting internally. As it increases in size and thickness, it assumes something of the appearance of cartilage, but is softer in its consistence, and only bears to it a general resemblance in structure. It is the nidus in

which calcareous matter is subsequently deposited in numerous small spots, which, increasing more or less slowly, at last form incrustations of various sizes, sometimes in small spots, sometimes in patches. These prevail in the aorta, but in the smaller arteries the calcareous matter sometimes forms complete rings or circles, proceeding even so far as to render the vessel a perfectly incontractile tube. The cartilaginous deposit is sometimes only covered by the calcareous incrustation, and never assumes the perfect character of cartilage in becoming bone as in other parts of the body. The calcareous matter is often deposited in spots, in which no sign of cartilaginous matter can be perceived. The exudation of a whitish matter, which subsequently becomes cartilaginous, is always found on the internal coat of the artery, and has been said to be deposited on the external surface of it alone, but never on its inner surface. A close investigation of this disease leads me however to the belief, that there is some inaccuracy in this statement, and that the new matter is deposited in the substance of this thin membrane or coat, which seems more particularly affected by it. The preparations in the Hunterian collection, from No. 333 to No. 345, were made by Mr. Hunter for the purpose of showing the process. In No. 337 and 338, the external and middle coats are healthy. The internal one is separated from them, in order to show the cartilaginous deposit. At one spot in 338, where a bristle is inserted, calcareous matter has been laid down in such quantity as to lead to the removal of the internal membrane covering it, and to the thinning of the external coats of the artery. In 339, the calcareous de-

posit implicates the middle as much as the inner coat; and in 340, the internal coat is less affected than in 337 or 338, in which the ossification is confined to the inner coat alone, whilst it is equally seated in both the inner and middle coats of 340. The preparation 359 A, dry, is the ascending aorta and arch inverted, to show the size of the scales of calcareous deposit in the ascending portion, which is also preternaturally dilated. In old people this calcareous deposit has been supposed to affect principally the middle coat, and to be deposited in the course of the circular fibres, constituting a different species of disease. It appears to me to be merely an aggravated state of the same disposition, affecting arteries of the second and lower orders, which begins in the middle coat, and not to merit a separate consideration. Mr. Hunter made No. 343, which is a part of the crural artery affected in this manner, to show the fact. The calcareous matter, increasing in quantity, gives rise through pressure to the absorption of part of the inner coat, and will then be in contact with the blood; by the attrition of which, portions of it may be broken off, and they have been found floating in it, or even obstructing a small vessel. Calcareous matter is sometimes deposited in considerable quantity on the outer coat of an artery, and not on the others. No. 344, shows two spots of this kind on the arch of the aorta: 345 is another portion of the same aorta, having a long elevated mass of bony matter adhering to it; but this does not seem to have depended upon chronic inflammation, but on what may be called a bony diathesis, many other parts of the same individual being similarly affected.

The lungs were nearly converted into bone, and large masses of the same matter adhered to the inside of the ribs. The lungs and ribs are preserved dry, being 548 of the dried morbid preparations.

The calcareous deposit has been found by Mr. Brande to consist of 65.5 of phosphate of lime, 34.5 of animal matter, chiefly albumen, with some traces of gelatine, but without any carbonate of lime. It is destitute of the usual fibrous structure of bone, is deposited irregularly, and resembles the callus of bone rather than bone itself. Wherever it is deposited, it destroys the elasticity of the vessel, and renders the coats so brittle, that a ligature will frequently cut through the external as well as the inner ones. The coats of the artery are however so altered by it, and the change which preceded its deposition, that those healthy actions which take place in a sound artery, for its consolidation after a ligature has been applied, do not always occur; and when the ligature is separated, the artery is found pervious, and hemorrhage is the consequence. It was principally from the consideration of this circumstance, that Mr. Hunter was induced to place his ligature in aneurism considerably higher up on the artery than the tumour, with the hope of finding it there in a sounder state.

The obstacle which the calcareous deposit offers to the free passage of the blood through the vessel, deprived in a great degree of its elasticity, leads also to the absorption of the inner membrane, the removal of a portion of the calcareous matter, and often to the formation of a small cavity with irregular edges, which may degenerate into an ulcer extending to the middle coat of

the artery, which has been greatly thinned, if not altogether removed. In some rare cases, near the root of the aorta, the ulcer has gradually eaten its way through all the coats of the vessel, and destroyed the patient by hemorrhage. In general the ulceration does not penetrate the external coat, but gives rise to ulcers or cavities more or less extensive, causing the part to assume a honeycombed appearance, which may lay the foundation for aneurism. The ulcerations frequently occasion small hollows, which are confined to the two inner coats of the artery, and appear to be filled up by a soft pulpy substance, sometimes containing calcareous matter, which has been usually called atheromatous. These cavities, which are essentially ulcerations, although often in the first instance dependent on a mechanical cause, are sometimes very numerous; the arch of the aorta, and for an extent of eight inches, having in one case been found covered by them.

Ulcerations formed between the internal and middle coats of an artery, take place without the presence of calcareous matter. Small pustules are seen in the first instance containing pus, which rupturing internally, become so many small ulcerations. These are sometimes so superficial as to appear like mere abrasions, but in general they are situated between the middle and internal coats of the artery; and, it has been supposed, in the cellular tissue uniting them; but as this is scarcely demonstrable, although it is believed to be the uniting medium, they may be attributed rather to an inflammatory action of the internal part of the middle coat itself. These ulcerations, as well as those already noticed, are of various sizes, and

sometimes put on a yellowish brown or black appearance, resembling an irritable ulcer in other parts: sometimes the inner membrane seems to be separated from the middle tunic, and blood is seen to have insinuated itself around them. They would appear also to be susceptible of cure, several small hollows of different dimensions being occasionally met with, which are lined by a smooth membrane, and seem to imply that cicatrization had taken place. Andral has once seen pustules situated below the internal membrane of the aorta as large as a small nut, and full of pus; but this kind of disease is certainly very rare. It is conceived that these pustules frequently degenerate into the flattened atheromatous or steatomatous patches, which are at a later period met with in diseased arteries.

It is said that the internal coats of arteries have been found affected with black spots or tubercles, resembling those which are usually considered melanotic, but I have not seen any thing of that nature.

The coats of arteries are subjected to other depositions between them, which have been denominated, from their substance and appearance, atheromatous or steatomatous; although the distinction between these terms, as applied to diseases of arteries, is by no means well defined or satisfactorily understood. The atheromatous or pulpy spot is more commonly found in connection with a thickened state of the middle coats of the artery, and is frequently accompanied by calcareous deposition. In some cases

these spots have been traced from the purulent state by successive changes into the soft pultaceous matter, which is denominated atheroma; sometimes it is a matter like that which is pressed out of scrofulous abscesses; it is often of a more opaque kind, and occasionally resembling cheese. The atheromatous patches sometimes pervade the whole surface of an artery, and are conjoined more frequently with calcareous than other matter, and a thin layer of this earthy deposit is frequently perceived on their surface. These patches are often found to yield by ulceration, by which the internal coat is destroyed, or is torn by the impulse of the blood. Where several of these patches exist, one or more have been found perforating the external coat by extension of ulceration, and destroying the patient by hemorrhage into the pericardium, trachea, or other parts.

I have said, that the internal and middle coats of the artery may be indiscriminately or conjointly the primary seat of the cartilaginous calcareous deposit. The atheromatous deposit seems principally to be dependent on disease of the internal surface of the fibrous or middle coat, although both the internal and external sooner or later partake of it. When the disease has made some progress, the coats of the artery will be found to be thickened generally; and when divided longitudinally into two parts, or slit open, the coats will be seen to be separated by a secretion or deposit, which is evidently covered by the inner coat, and which appears to have been formed by the middle coat, and deposited between it and the internal one. A

stage further and the middle coat seems to have been removed, although the quantity of matter may not be greater. By this time the inner coat has become diseased; in some parts there may be thin scales of calcareous matter, in others the inner coat may be even ruptured or removed, whilst the outer coat of the artery has been in places rendered so exceedingly thin as to show that a rupture was on the eve of taking place. The preparations, No. 325 and 325 A, 328 and 328 A, and 331, establish these facts. No. 325 shows the outer coat apparently healthy through the whole length of the preparation, which is of the ascending and descending aorta. The inside of the artery is nearly covered by patches or flattened tumours of all shapes and sizes, projecting into the canal, but not outwardly. The inner coat passing over these elevations seems to be sound, and they appear to be dependent on a disease affecting the inside of the middle coat, which is at these parts of twice its natural thickness. The inner coat is turned down at the upper corner, to show the difference between the middle coat in a part where it is sound, and in the patches where it is diseased, and seems to have lost its fibrous character.

No. 328. The outer coat of the aorta is apparently sound, the inner is thickened, cartilaginous, with some calcareous deposits in places. The external coat is turned back at the lower corner to show its state. The middle and inner coats are separated from each other, the middle being thinner than natural, the inner thicker; a bristle marks the deposition between them, supposed to have been atheromatous.

On the inside, near the centre, a bristle is inserted to show the inner coat broken up or ruptured, the middle destroyed, the outer so much thinned as to have nearly yielded by rupture.

No. 331. Supposed to be a more advanced stage of the same disease, at the lower part of the aorta. At the upper part, and left-hand corner, a small cavity is observable, capable of admitting the end of the little finger. The outer coat is reflected to show its apparent soundness. The inner membrane is ruptured or destroyed. The middle coat is very much attenuated and diseased, especially on its inner side, and separated from the outer wall of the cavity, the contents of which had been in part, it is presumed, carried into the canal of the artery. A scale of calcareous matter was observed at this part as well as at others. At the bifurcation two more cavities are seen, one in each iliac: that at the left-hand corner is oval-shaped, about an inch long, projects inwards, and has greatly encroached on the canal of the artery, so as in part to fill it up. It would probably have rendered it impervious, if the outer coat of the vessel had not yielded by ulceration or rupture.

No. 368 A, shows in the descending part these patches in an admirable manner. In the fresh state, the contrast between the whiteness of their appearance and the deep red of the aorta in the interstices between them was remarkable; and as there was not any coagulated blood in this part of the aorta, it is reasonable to conclude this redness was the result of chronic inflammation, and not of imbibition, more particularly as the inner coats were soft and easily

torn. This preparation will be afterwards referred to as an instance of the dissecting aneurism.

No. 325 A, and 328 A, show these patches accompanied by a greater quantity of calcareous deposit.

No. 325 A. The ascending and descending aorta. The ascending portion is preternaturally dilated to a considerable extent. The descending part is not dilated, but is slit open to show the extent of disease on the internal surface, which is the atheromatous patch covered in almost every point by a calcareous scale. The ascending part does not appear to be affected to the same extent.

No. 328 A. The aorta with the sigmoid valves, and a portion of the ascending part enlarged and greatly thickened. The valves are much ossified: the inner membrane is covered with scales of different sizes, but generally small ones. In one part the scales are raised, and show that other matter is deposited besides the ossific. On the outside the coats have been turned back. The external one is quite sound; the outer part of the middle coat seems so likewise; but the inner part is thickened, adheres firmly to the ossified inner coat, which is continuous, but quite calcareous, and seems to have been separated with difficulty.

The disease shown in No. 331 and 328 is I believe peculiar, and one that has not hitherto been described. It is of a nature in some respects similar to that shown in the other two preparations, although not exactly resembling them. It leads I suspect in general to the rupture of the artery rather than to the formation of an aneurism. If an aneurism be formed by such a

disease, the sac must be composed of the loose cellular texture which surrounds the great vessels exterior to their cellular or external coat, which in those situations is rarely adequate for this purpose. This disease therefore tends to a rupture of the vessel rather than to aneurism, and is I believe the disease which has given rise to the rupture of the aorta in No. 368.

The arch of the aorta has been removed with its semilunar valves, and as far as about half an inch below the origin of the left subclavian. It is very little if at all dilated, but has a rent in it on the posterior part, which externally is nearly vertical, and one inch and a quarter long; the lower margin of it being a little more than one inch and a half above the valves. The rent in the middle and internal coats correspond, as they adhere to each other; but it is not in the same direction as in the outer one, being diagonally across it and one inch only in extent, although a fissure marking a continuation of it for near an inch further can be distinctly seen. At this part the middle coat adheres still to the outer one, which has prevented the completion of the fissure into a rent. At the remaining part, where the hole is complete, the outer coat is separated from the middle and inner ones, and the sac or separation thus formed is capable of receiving the first joint of a good-sized man's thumb. In that part of the arch where the left carotid and subclavian are given off, two, indeed three, small pouches may be observed, capable on the inside of receiving the extremity of the fore finger. One pouch has been opened, and the wall of the artery turned up. The inner coat has not its natural ap-

pearance, is evidently thickened, and spotted as if from deposition beneath it. The same appearance is observable in the artery near where the rent has taken place. The artery is not ossified.

It will be said that the rupture took place in this part of the aorta because the covering is serous, not cellular, and therefore not allowing of the increase and thickening of the external coat at an early period, by the consolidation of the cellular structure; and this is the view taken by all the continental authors on this subject. It will be shown that this is altogether an error, and that dilatation will take place as readily and to as great an extent in the aorta close to the heart, where it is only covered by the serous reflection of the pericardium, as it will in any portion of the descending part of it in the abdomen, or elsewhere. The rupture or dilatation, whichever of the two occurs, depends on the nature of the disease, and not on the nature of the external coverings or connections of the artery. After the dilatation has begun, its increase, rupture, or ulceration, depends very much on the parts implicated by it.

The symptoms which indicate the existence of chronic inflammation during life are so obscure, and are in the commencement so trifling, that few persons are aware of their presence, and they equally escape the observation of professional men. There are few persons past sixty years of age, in whom some change has not taken place in the commencement of the arterial system. It is only, however, when it has proceeded so far as to cause some obstacle to the circulation, that the symptoms of disease present them-

selves, and are augmented by others, the result of derangement of the neighbouring organs. Difficulty of breathing on a moderate effort, such as going up a rising ground or a flight of stairs, first occurs, followed by palpitations in the chest, a severe cough and mucous expectoration resembling asthma or chronic bronchitis; a gradual failure of strength and appearance, irregularity of pulse, sallowness of countenance, œdema of the limbs, and frequently dropsy or suffocation lead to the termination of the sufferings of the patient.

The steatomatous, or flattened tubercles, are of various sizes: when they are numerous they are generally small but irregular patches, depending for their formation on disease of the middle coat of the artery, and are usually supposed to contain a more solid matter of a yellowish or dun colour, resembling wax or hard fat; but the distinction, I have already said, is not satisfactorily established between them and the atheromatous patches. They are sometimes of a large size.

Stenzel first noticed this kind of tumour. He says (Dissert. de Steatomatibus Aortæ, 1723), "Altera harum excrescentiarum, in angulo aortæ ubi incurvatur sita erat; altera vero aliquantulum ab hac distans descendentem occupabat ramum. Hæc corpora in tantam istum canalem molem extenderant, ut ipsum ferme cor magnitudine æquaret, omneque propemodum exeunti a sinistro cordis thalamo sanguini spatium præcluderet. Hi tumores, digitis admotis pressi, plane non cedebant, nullam que ob summam qua pellebant duritiem foveam relinquebant; hinc unum de his inci-

dendum, cultroque, atque examini anatomico subjiciendum esse necessarium ducebamus; quo dissecto et aperto, membrana satis crassa et firma, vitulino crassitie corio æmula, illo tamen adhuc durior, colore albicante ad incarnatum accedente prædita, striisque multis per totam superficiem notata oculis occurrebat nostris. In hujus cavitate materia quædam sebosa, et adipi perquam similis firmiter compacta inveniebatur."

Corvisart has given an account of two dissections, in which he met with tumours of this description, which he thinks throws some light on the formation of false aneurisms. "Having opened the chest of an individual whose history was not known, and examined the heart and lungs, which were sound, I found on the anterior part of the curvature of the aorta a little tumour, of the size of a nut, of a black colour, which I took at first sight for an enlarged bronchial gland; but wishing to push the scalpel into it, I was surprised by the resistance it offered to the knife. This induced me to examine it more attentively, when I perceived that it was a fibrous sac, which adhered by its base to the side of the aorta, to which it appeared in some way to belong. It was formed by an external fibrous covering nearly two lines in thickness, and contained a substance of less consistence than tallow, of a deep red colour, and resembling otherwise the coagula of blood, which have long adhered to the inside of an aneurismal sac.

"I suspected a communication with the cavity of the vessel to which it was attached, but looked for it in vain. The external layers of the aorta, at the point

corresponding to the cavity of the sac, were destroyed, and the thickness of the coat of the artery was at this particular spot infinitely less than at any other point. Having opened the artery longitudinally, I could not perceive any opening into the sac, but a small greyish livid spot appeared to correspond with the bottom and thinnest part of the tumour. Lower down in the aorta, above where the cæliac is given off, I discovered another swelling similar in every respect, save being of a smaller size."

In 1786, in dissecting a body for other purposes, he says that he saw two or three tumours of the same description on the ventral aorta, and one on each of the common iliacs, and does not doubt that they were formed in a similar manner. He considers that the opening only was required to be perfected to cause them to become false aneurisms.

Mr. Hodgson, in his admirable work on the Diseases of Arteries and Veins, has doubted the correctness of the inference drawn by Corvisart as to these tumours being in the course of formation to become aneurisms, and has supposed that they were on the contrary aneurisms which were undergoing a spontaneous cure. He says, "The appearances in these cases were so precisely similar to those exhibited in Case 22, 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 extent in the cases recorded by Corvisart, than in any of the instances that I have had an opportunity of examining."

The following is Case 22, referred to above:—

"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 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 twelvemonths 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 a half 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."

Mr. Hodgson is followed in his opinion by all the later continental authors; and it is a matter of no practical importance whether they were aneurisms in progress, or terminating in a cure, yet from what I have seen I cannot but suspect that Corvisart may be correct. That he was an accurate observer will be admitted by every one, and ought to have known the base of a coagulum, however membranous in appearance, from the internal coat of the aorta. Moreover, the contents of his tumour was a substance *of less consistence than suet*, whilst in all the cases of spontaneous cure, in which from the history the previous existence of aneurism was known, the contents have always been *firm, or very firm*. His remarks on the external and internal coats are explicit, and unless he be considered inaccurate both in observation and expression, I think it will be allowed that he may possibly be right in supposing that a tumour may be formed external to the inner coat of the artery, which may subsequently cause its removal by absorption, and become the seat of aneurism; that is, that the cavity

may be formed exterior to the inner coat before it gives way. There is very little wanting in some parts of the preparation 331 for this to take place, although it is probable that the external coat would then have immediately yielded, and a rupture rather than an aneurism have been the consequence.

When these steatomatous tumours are not so distinctly prominent, they become thicker and broader as the deposition takes place, and often coalesce. The external coat is elevated, whilst by protruding interiorly they diminish the canal of the artery. The inner membrane, thus detached and pressed upon, becomes irregular, opaque, shrivelled, and discoloured, previously to its removal by ulceration, which is not however so common an occurrence as in atheromatous tumours.

The steatomatous patches are often connected with ossification of the coats of the artery. In some of them an earthy matter is mixed with the steatomatous deposit, but it is not in general of so hard a texture as that usually found in the true calcareous spot, accompanying or following a cartilaginous state of the vessel.

The coats of an artery, in its natural state, are so intimately connected with each other, that they are separated with difficulty by dissection. The medium of connection is presumed to be the cellular texture, although the existence of it has been doubted because it cannot be distinctly shown. The great separation which in some particular cases is effected between the outer and middle coats, appears however to establish the fact of a connecting medium of this kind, and to de-

monstrate a species of disease which has been but little attended to, although I do not believe it to be as rare as has been supposed.

The simplest form is said to be that in which the internal and middle coats having given way, the external coat is only slightly separated by the blood effused beneath it. The chronic inflammation, which preceded this state, having however thickened the general surrounding wall of the artery, the separation of the external from the middle coat is effected with difficulty; the external coat becomes stretched and distended, and an aneurismal tumour is formed in the manner which has been so frequently described, although the accuracy of the description may be doubted. The separation to which I allude is much more distinctly marked, and the disease seems to have existed in the uniting medium, and between the coats of the artery, as much as in them: whilst the whole may be thickened, the separation is distinct.

In the first, or simplest kind, the tumour formed by the effused blood is circumscribed, and usually small in size. In the case to which I refer, it is otherwise; the blood is forced along the tube of the artery, separating in the simplest manner the external and middle coats from each other, and forming for several inches a long pouch or bag, which may or may not surround the vessel. In one case it formed a long pouch on the anterior part of the descending aorta, about six inches in length, extending to the sides, and in one place nearly surrounding it. A horizontal fissure, about half an inch in extent, near the upper part of the swelling, allowed the blood to pass

through the inner and middle coats, and to effect this separation, which could only have arisen from disease previously existing in the part. This occurred many years ago, and I was not then aware that it was a peculiar or uncommon appearance.

Laennec has reported a case nearly similar, but to a greater extent, in a person who was not suspected during life to have disease of the heart or arteries.

"The heart exceeded in size the two fists of the person*. The right ventricle was small, its walls rather thin, and it appeared as it were imbedded in the greater thickness of the walls of the left. Its cavity was filled with polypous concretions of a very firm consistence, extending between and surrounding the columna carnea. The cavity of the left ventricle was not capable of holding any thing larger than an almond in its husk. Its walls were an inch and a half thick in some places, and an inch at the thinnest, except at the apex of the heart, which was only two lines in thickness. The sigmoid valves of the aorta had three or four excrescences adhering to them of a fleshy consistence, and very much resembling venereal warts. The arch of the aorta was dilated so as to be able to contain a middle-sized apple, and was incrusted with several calcareous scales. About two inches below the beginning of the aorta descendens, a transverse opening was perceived, extending over two-

* The natural size of the heart is supposed to be equal to the closed hand or fist of the person. The wall of the left ventricle to bear the same proportion to the right, that the aorta does to the pulmonary artery, *viz.* to be double or something more than double the thickness.

thirds of the cylinder of the artery, which had however only penetrated through the internal and middle, or fibrinous coat. The edges were thin and irregular, as if torn in places. The external or cellular coat was healthy, but separated from the middle coat, from the opening downwards as far as the origin of the primitive trunk of the iliac arteries; so that at first sight it appeared as if the aorta was divided transversely by a partition. The separation was not complete, having only taken place in about two-thirds or half of the circle of the vessel, and not always directly in its axis, but occasionally turning round it, although confined principally to its posterior part. It extended for some lines on the trunk of the cæliac and iliac arteries, and was there complete: upwards it reached as high as the curvature of the aorta, forming a sort of oblong sac, the walls of which were of a deep violet colour, not removable by scraping with the knife. In some places this colour was less deep, or did not exist at all, and in others cartilaginous spots deeply seated in the fibrous coat (the rudiment of calcareous deposits), formed a contrast by their whiteness with the deep red colour of the wall of the sac in which they were situated. The sac was crossed in several places by the intercostal and mediastinal arteries, and was filled with coagula of blood, and polypiform fibrinous concretions, nearly all of which were of a violet grey colour, partly transparent, and of a very firm consistence. One edge of the extremity of the slit, or opening, resulting from the rupture of the two inner coats, being a little lower than the other, had contracted an adhesion of some lines in extent with the

external coat, by means of some short, firm, reddish filaments, which were evidently fibrinous concretions, presenting the appearance of a commencing cicatrization."

"The external coat was perfectly healthy in the whole length of the aorta, and particularly opposite the part where the inner and middle coats had given way. The vasa vasorum, filled with blood to their smallest ramifications, gave it a violet grey colour. This constitutes one species of aneurism, called the *dissecting* aneurism."

Since the above was written, I have met with another instance of this disease in the aorta of an old woman who died suddenly. It is No. 368 A, and a most valuable preparation, from the number of facts which it demonstrates. The woman was supposed to be asthmatic and incurable, and on making an exertion in getting up in bed, she fell back and expired almost immediately. It shows the heart, the pulmonary artery cut across to expose the origin of the aorta. The valves much ossified and thickened, as well as the membrane below them. The ascending portion of the aorta greatly dilated, and of a red wine lees colour. Just below where the innominata is given off, the inner and middle coats are ruptured for half the circle of the aorta on the great curvature, as clean as if cut with a knife, and in a straight line around. The effused blood separated the outer from the fibrous coat, down to its origin; along the fore part and around the great curvature to the back part, dissecting thereby two-thirds of the artery. The fibrous coat is equally red, and in part turned back, separated from

the inner coat. The outer coat with the reflected portion of the pericardium adhering is distinctly seen, and the pericardium is in part turned back. The fore part of the aorta is laid open, as well as the left carotid. The arteria innominata is a little dilated generally, and slit open from behind, to show another rent of all the coats of this artery, which runs transversely across the anterior half of it, and from which the hemorrhage took place which killed the patient. The dissecting process has also been continued for an inch beyond the left subclavian on the descending aorta, and the effused blood was contained within it. The descending portion of the aorta and the roots of the great vessels are covered with atheromatous patches, some few having bony scales. The coats were all easily separable by the fingers from each other, and softer and more readily broken than natural. The left ventricle is one inch thick, and the mitral valves are also thickened and indurated. The same atheromatous patches are seen in the coronary arteries as in the aorta; their whiteness was finely contrasted in the fresh state with the deep red colour of the interstitial part of the artery.

In this case, the freedom of the ascending aorta from the atheromatous patches which covered the inner membrane of the descending part of it, and thickened the sigmoid valves, deserves remark; as well as the facility with which the inner and middle coats were torn on a very slight degree of extension; leading to the belief that inflammation had gone on to a certain extent, softening these parts until they were unable to resist the force by which the blood was pro-

pelled by the thickened ventricle. Some coagulable lymph was thrown out around the rent in the arteria innominata, as if inflammation had been set up external to it before it yielded. The redness which exists in the ascending aorta is perhaps in part from imbibition, that of the inner part of the descending aorta was certainly from inflammation, there having been no blood found in that part, and the patient died suddenly. The preparation was also taken out within twenty-four hours, and the softened texture of the inner and middle coats marked the disease in a manner that could not be mistaken.

OF THE

PRETERNATURAL DILATATION OF ARTERIES,

AND OF

ANEURISM.

The word *aneurism*, or if written according to its etymology *aneurysm*, is derived from the Greek word ἀνεύρυσμα, an "enlargement," or "dilatation." In common surgical language it is received as a generic term, signifying a dilatation or a rupture of a part, or of the whole of the coats of an artery, but without any external communication, which would render it either a wounded artery, or a ruptured aneurism, requiring a different mode of treatment.

The ancients had not clear ideas on this subject, but made use of the word aneurism, to signify a tumour formed (from whatever cause) beneath the skin by the extravasation of blood from an artery. They had no knowledge of the disease occurring in the internal parts of the body; and the first known case of aneurism of the aorta was discovered by Vesalius about the year 1557. It was not however for more than a hundred years afterwards, that the frequent occurrence of this complaint became the subject of dis-

cussion; when the idea of a complete rupture of the coat of the vessel in internal aneurism yielded to the theory of Fernelius, who supposed the disease to depend on a dilatation of the artery. This opinion was not established or even supported by cases observed on dissection, either by himself, or Forestus, the greatest advocate for his opinion; and was opposed on that ground by Sennertus, who maintained that the internal coats of the artery were ruptured when the disease occurred spontaneously, or divided and not reunited when it took place from injury; and that in both, the cellular or external coat was dilated. Scarpa has supported, with the whole weight of his authority, this opinion; but contemporaneous and later observations have proved from dissection, that neither this, nor any of the exclusive theories of the formation of aneurism are correct, there being several ways in which it may occur. A conclusion, which surgeons in England might have arrived at thirty years ago, if they had taken the trouble to examine the specimens of aneurism in the Hunterian collection.

The whole circumference of an artery, such for instance as the aorta, is sometimes found dilated, forming a large sac; the coats of the vessel always partaking more or less of disease: yet so far perfect, particularly the inner membrane or tunic, that no blood is deposited in it by coagulation in concentric layers, the circulation continuing through it. This is called a *preternatural dilatation.*

Preternatural dilatations are most frequently met with in the ascending aorta and at the arch: they have

been less often observed in the aorta descendens. They are not uncommon in the arteries within the skull. I have twice seen the ophthalmic arteries in the orbit dilated in this manner; and the same state has been observed at the divisions of the larger arteries in various parts of the body.

The aorta is often dilated in the whole of its circumference without any marked disease in its coats, unless it be that they appear to be thinner than usual; although they more frequently retain their natural structure, or become even thicker, indicating thereby an accompanying growth as a compensation for the loss of elasticity, which has in all probability taken place. The cause of the deprivation of one, and the increase of the other, is not satisfactorily accounted for; although it is very likely to be a species of chronic irritation, which continues until some more marked change of structure takes place. This is often the deposition of a quantity of calcareous matter; at other times the formation of atheromatous and steatomatous patches, leading to the absorption, or rupture, or ulceration of the inner and middle, and ultimately to the rupture or distension of the outer coats of the vessel.

An artery is said to be preternaturally dilated, when it is enlarged in its whole circumference; to be aneurismal, when the tumour seems to grow from one side or part of the artery alone. This external distinction must however be supported by internal appearances, supposed to be characteristic of the two diseases, in order to render the definition complete. In a preternatural dilatation, the internal coat of the

artery is presumed to be, although dilated, sufficiently sound to exercise its natural functions; the blood does not therefore adhere to it, and no old coagula are found within it. In the aneurismal tumour, the internal coat of the artery, even if present, is rendered incapable by disease of continuing its natural functions; and the deposition of coagula, at first soft, and afterwards in concentric layers, is the consequence. When the preternatural dilatation has proceeded to a great extent, coagula are often found in it; but these have more the appearance of accidental irregular formations, than of concentric deposits in layers; and, unless of long standing and small, have a less firm and fleshy consistence. It has also been shown, that when the inner coat has been so distended as to suffer abrasion or rupture, coagula may even be deposited in layers, although not to the same extent as in a small or even recent aneurism. It is a distinction established particularly in England, for the sake of clearness of expression, without being of any practical utility, and the same may be said of all internal aneurisms.

The blood in an aneurism does not pass freely through or over the dilated part, however small, but is in some degree deposited from the earliest period, first as a soft coagulum, and afterwards in layers on the inside of it; forming as above stated a distinctive mark between an aneurism and a preternatural dilatation. It is not necessary that the inner coat should be removed before the deposition takes place. It appears, that with the commencement of the alteration of its function, and certainly before its removal by absorption, a change occurs,

by which the property it possesses during health, of preventing the adhesion of the blood to its surface, is lost. This change is in all probability an increase of action, approaching to that of inflammation. If it be sufficient however to cause an obstacle to the easy passage of the blood through or over the part, the deposition of coagula takes place as a consequence, until in some rare instances the canal of the artery becomes obliterated, and a spontaneous cure is effected. The preparations from No. 376 to 380, 382, 387, 394, 395, 396, 404, and 405, were made to show these aneurismal coagula from the first or outer layer adhering to the sac, to the most internal. The differences of structure, from the half concentric layer to the thick dense spot seen in No. 405, are well exemplified. No. 375 shows a coagulum of blood from an aneurism in a lion: it appears singularly loose and spongy in its texture, indicating that the nature of the coagulum at different periods, depends in all probability on the various states of the blood. The external layer adheres more or less firmly to the coat of the artery, but not in such a manner as to admit of proof of any organization having taken place in the coagulum through the medium of vessels. The action in the internal coat of the artery in its approach to inflammation, although capable of altering the function of the part, not being apparently sufficient to give rise to the formation of a false membrane, to which the coagulum might intimately adhere, and from which it might become organized; a circumstance which is further discredited by the fact, that at an ulterior stage of disease, when the aneurism bursts, the blood is found to force its way not only

between the layers of coagulum, but between the first layer and the sac to reach the surface; which it would not be likely to do if an intimate union by vessels had taken place.

In large aneurisms, the layers of coagulum suffer a considerable change in the course of time; altering in appearance and in character, and undergoing as it were a species of decomposition, which perhaps leads at last to the insinuation of blood between the layers and to the ultimate rupture of the sac. The blood, when first coagulated, forms a soft coagulum, which gradually becomes firmer, loses its dark red colour, and assumes more and more of a fibrous appearance; changes which undoubtedly occur after coagulation, and continue until the layer is found of a pure fibrous character, composed essentially of fibrin, and of a reddish white or ash colour. Sometimes it is quite opaque and firm, at other times and in very old aneurisms partly transparent, and resembling horn or glue a little warmed and softened before the fire. In some cases, further changes will be found to have taken place exterior to this, and the matter deposited will be found softer, more pliable, easily broken up between the fingers, and offering little opposition to the passage of blood through it.

Polypous concretions and common coagula are frequently found in the heart and great vessels, when they have been diseased, or the person has been long in dying. In the preternatural dilatation of an artery, coagula are not found in the same concentric layers as in aneurism, yet common soft coagula have been frequently seen in such cases, and

it is possible, that even a deposit by layer may have been begun, where the removal of the inner coat, or the utter loss of its function in respect of the free passage of the blood over it, has taken place. Polypi deposited or formed from the blood during the last hours of life, are found generally in the right auricle and ventricle, and the commencement of the great vessels. They differ from common coagulated blood in being usually of a yellow topaz colour, nearly transparent like jelly, and adhering only by simple contact of parts, even if surrounding the fleshy columns of the cavity of the ventricle. In some cases they surround, in others they intermingle, and occasionally form only a partial covering to the clots of blood contained in the heart. But polypi are found which certainly existed some time previously to the death of the patient. These are firmer and less transparent, indeed have become opaque and fleshy. Where the recent coagulation would be yellow, the more ancient one is of an ash colour, the red part will be violet, and the adherence to the walls of the heart more marked and firm. These concretions become in time organized, and it is likely that they always depend for their formation on an inflammatory state of the inner membrane of the heart or great vessels, which is not the case with the more common polypi. The concretions which appear capable of becoming organized are never large, and form either small projections at particular parts, or adhere over a larger space to the surface. The valves of the heart and of the great arteries are subjected to excrescences of this nature, as well as to ossification, laceration, inversion, &c.; and it appears

to me that they are caused by the same degree of low inflammation, and not by mere deposition. They are more common to persons who have been hard drinkers of raw spirits, and have no pretensions to a syphilitic origin. The preparations 311, 308, 308 A, 308 B, are good examples of this disease of the valves of the heart.

In some very rare cases of preternatural enlargement of the aorta, and of other vessels, the coagulum is formed around the sides of the artery, leaving a passage for the blood through its centre as a proper canal. The preparation No. 372 is perhaps unique. It shows this very rare occurrence. The left subclavian is also obliterated; and two small aneurisms are forming, where aneurisms have been said never to take place.

No. 372. The aorta from the sigmoid valves, which are entire; about half an inch above them the artery begins to enlarge, and is diseased on its internal surface in patches of calcareous deposit. The arteria innominata and left carotid are pervious. The left subclavian is closed at its orifice by coagula, which appear to have lined the dilated vessel, leaving a channel through the centre for the blood. The canal in the coagula seems smooth as if lined by a false membrane. The line of distinction between the preternaturally enlarged part which is without coagulum, and that which is lined by coagula, is sufficiently marked, and runs from the top of the arch towards the inner or under edge of the curvature below.

Two small depressions are seen on the posterior part, midway between the valves and the arteria innominata, one larger than the other, and each containing a bristle.

They are the commencement of two small aneurisms, the edges are very well defined internally, and the sacs equally as well externally. In the larger one, the external coat is turned back as well as the middle one; the inner one remains entire, and continuous with the inside of the artery. A deposition of a quantity of yellow atheromatous matter has taken place on the inside of the middle coat, destroying its structure, and even pressing upon, and altering slightly, at one small spot, the outer one. The defined edges of the cavity are here seen not to depend on a rupture of any kind, but on a thickening of the vessel at the part. The smaller aneurism shows the same thing: the edges are remarkably well defined, and no one can examine and then compare them with No. 397 A, which shows a globule of quicksilver contained in a small cavity of the same description, without being struck by their similarity.

When the walls of an artery yield by dilatation in any spot, not including the circumference, but (as is usually the case) on one side of the vessel only, and frequently in a small space, it is called a *true aneurism;* the internal and middle coats being found perfect on examination, even by maceration. This state of disease is for the most part only seen distinctly in small aneurisms, for as they increase in size, the inner and middle coats appear to be removed by absorption; they may perhaps in some cases be ruptured. The first step in the formation of an aneurism in a part of the aorta which is even preternaturally dilated, is the deprivation of a greater portion, if not of the whole of the remaining elasticity which the part possessed.

This is followed, if not accompanied, in general by the deposition of a curdy yellowish matter at the spot, which now becomes dilated to the whole extent of the deposit, and this probably regulates the size of the opening between the aneurismal sac and the artery generally. The dilatation is usually at first more or less circular or oval, from the size of a large pin's head upwards, to any extent the artery will admit of. In some instances it seems to form a sort of split or fissure rather than an oval opening. If an aneurism of the size of a pea, or of the end of the finger be examined, by making pressure around it; a small quantity of the yellowish curdy matter may frequently be pressed out from under the inner coat, which yields to allow it a passage. If a careful dissection be made from without inwards, the three coats may be always distinctly shown, and this same yellowish matter demonstrated as dependent on the middle coat. From the first moment that the aneurismal dilatation takes place, and before it is large enough to admit the end of the little finger; it becomes filled with a soft coagulum, forming a striking difference when compared with the enlarged but empty preternaturally dilated aorta in which this little aneurism is situated. From the moment the spot yields, so as to form the commencement of an aneurismal sac, the edge of the artery surrounding or enclosing this sac becomes thicker and firmer, so as to form a distinct thickened, yet well defined although rounded edge. This edge seems to be the product of a healthier inflammation than that which has given rise to the deposit of the atheromatous or yellowish curdy matter alluded to.

It is set up by nature to form a boundary to the mischief, as healthy inflammation is established in other parts of the body, previously to the formation of a line of separation between those which are mortified and those which are sound. Over this edge the inner and middle coats of the artery can always be traced; and even throughout when the sac is small, and for some distance beyond the edge when it is large. In this last case they soon become confused, and are often so blended together as not to be traced; although at others the termination of the inner coat may be seen, as if it had been irregularly removed or torn. It is only then in small aneurisms that the structure of the sac can be fairly traced; for when they have attained a large size, the aggregation of matters external to them, and the slow but continued action which is going on, render a distinct separation of the component parts of the sac impossible.

When the aneurism has increased in size to that point at which the inner and middle coats begin to be removed from the centre of the tumour, the external coat forms the sac. It does not usually remain of its natural thickness, or is simply dilated and thinned. On the contrary, from the commencement of the separation, and indeed before the removal of the internal coats, some degree of increased or altered action has taken place, which appears to be afterwards augmented. The pressure from the enlargement of the sac gives rise to irritation and the formation of adhesions with the surrounding parts, as if nature endeavoured to prevent the mischief impending from rupture. As soon as the sac meets with an opposition to its dilatation, arising from

harder or more resisting parts, absorption begins; the sac becomes thin and is ultimately removed. The hard parts, such as bones, follow by that process of absorption called by Mr. Hunter progressive, in which that action of the small arteries necessary to constitute inflammation is wanting; there is therefore little comparative pain at the commencement of the process, and no formation of matter Cartilages from their elasticity resist this absorbing process more successfully than bones; those of the ribs will remain after the bone has been removed; and the intervertebral substance appears to be unaffected, when the bodies of the vertebræ have nearly disappeared. After the hard parts have been removed, the progress of the aneurism is more rapid. The skin becomes distended, loses its furrows, and assumes a shining white appearance. This is soon changed to a copper-coloured hue: some one or more parts of the external tumour become elevated: the skin over them becomes dark coloured, and an evident slough is formed. This slough does not yet yield altogether; blood begins to ooze at the edge in one or more points, and slowly increases in quantity until it gradually destroys the patient; or a sudden and more rapid discharge at once closes the scene: a catastrophe which may in some instances be uselessly delayed, by supporting by compress and bandage the part which seems to be the weakest and the most likely to yield. When an aneurism protrudes into a cavity lined by mucous membrane, the process is much the same; but it is said that the opening which takes place into any cavity or canal lined by serous membrane, occurs by rupture and not

by sloughing. In some very rare cases, when an aneurism approaches to and gives rise to inflammation of the periosteum covering the bones, ossific matter is thrown out, forming a sort of wall to the tumour, and impeding its progress in that direction; but I suspect a peculiar diathesis to exist under such circumstances.

Sarah Bottwood, aged thirty-seven, received a blow nine years ago from the corner of a bedstead on the left breast, and felt pain and throbbings in that part ever since. In the course of one year after the accident, she perceived a tumour about the size of an egg projecting between the ribs: it beat strongly, and was attended by severe pains between the shoulders. She found great relief from bleeding, and was frequently obliged to have recourse to it. Since February 1829 the tumour has gradually increased; and in May a small but softer swelling appeared between the fifth and sixth ribs and the edge of the sternum, which broke and discharged blood, which it continued to do until her death, but it brought no relief. At the end of November she felt something suddenly give way, and the swelling rapidly increased to four times its previous size. It now occupies the whole breast, which is as large as a child's head of three or four years of age, pulsates strongly, and discharges blood at two points, one the above-mentioned place near the sternum, the other near the axilla. She suffers from great pain and a teazing cough. The skin is very tense and shining, and the tumour very elastic. Towards the middle of December the skin assumed a copper colour, which shortly changed to a dark brown

or black, being evidently a slough, which had nearly separated when she died exhausted, on the 30th of December, from continued hemorrhage, which took place from the two small openings. On dissection, the ascending aorta was found unusually thin, preternaturally dilated, and of large size, but without either blood or coagula within it. The opening into the aneurismal sac was on the anterior part, forming externally a sort of neck between the two parts. The coats of the ascending aorta were not sound, and here and there patches, having a scaly matter on their surface, were perceptible; the base of the aneurism, where it passed through the walls of the chest, being five inches across, the second, third, and fourth ribs having been absorbed. The aneurismal sac was full of coagulated blood, but of two kinds, one part being firm, fibrous, or fleshy, of a pale reddish white colour, and situated between the soft black coagulum, which occupied the internal part of the aneurism, and filled the outer part. The blood appears to have forced its way through this firm coagulum, and to have thus given rise to the rapid increase of the swelling, and ultimately to the death of the patient by hemorrhage.

When an aneurismal sac is formed upon a preternaturally dilated artery, it sometimes happens that the walls are thinner than usual; and some parts of these are even more attenuated than others; they then become dilated to a greater degree, and constitute pouches or sacs proceeding from the aneurism itself, and giving to it a remarkable *sacculated* appearance, these prominent points being always the thinnest. No. 366 elucidates and establishes this point in an ad-

mirable manner. It is the only instance of a *sacculated* aneurism in the collection, and of an aneurism opening by ulceration into the pulmonary artery. There is indeed only one other instance of disease of this artery, and that is of dilatation, being No. 1 of the dry preparations.

No. 366. The aorta with part of the ventricle. An aneurism by dilatation springs from the ascending part, which otherwise shows little sign of disease. The sac seems to be strictly formed by dilatation and thinning, in proof of which, the external coat at one part is reflected, and a bristle placed under it; the middle coat is also turned back in a different direction, and a bristle placed under it: the internal coat is seen in situ; the outer coats are thinner than usual; but the greatest diminution of thickness appears to have taken place in the middle one. The general sac is subdivided by a partition into two large sacs, one of which is again divided into three projections, giving altogether to the outside of the swelling a sacculated appearance, resembling in some degree the colon when distended with air. One of the small sacs arising from the larger one, and looking like a nipple, has opened into the pulmonary artery by a nearly circular orifice, about one-fourth of an inch diameter, having well-defined sharp edges, situated immediately above and between two of the sigmoid valves.

When aneurism occurs in any part of the body from disease of the coats of the artery, and not from an accident or injury, it is commonly supposed to depend on a disease which is more or less general in the vicinity of the tumour. This opinion is for the most part

correct, and regulates in a great degree the surgical practice to be pursued. It is however well known, that an aneurism may form in an extremity, and the person recover after operation, without having a recurrence of the disease in any part. I knew a man some years ago, who survived the operation for popliteal aneurism in both limbs for twenty-five years, and died at last of fever. The preparation 411 G is rare and valuable, inasmuch as it shows a double aneurism in the aorta at one spot, the remaining part of the artery being perfectly sound.

No. 411 G, an aneurism of the descending aorta, every part of the artery being healthy, except where the aneurism exists, which is as large externally as an orange. The artery is slit open to show the entrances into it, there being two, separated by a transverse band, consisting apparently of the three coats of the vessel. The upper opening is oval, the edges sharp and well-defined; the cavity is nearly filled with coagula. This aneurism burst at the right and anterior side. The lower opening goes into a separate sac, not communicating with the other, and about the size of a pigeon's egg. The edges of this opening are not so well defined, but irregular, and the internal coat extends further over them and into the sac, which is empty. A vessel, and in all probability one going to the liver, is pervious into this sac. The artery is quite sound up to the very edge of the upper opening, where it seems to have suffered from chronic inflammation, giving rise to the atheromatous patch, and terminating in aneurism.

It has been stated, and that very lately, that no

vessel is given off from an aneurismal sac; which assertion has probably been made on the ground, that the orifice of such vessel, if there were one, would be closed up by the coagulum which lines the sac. The records of operations performed by the older surgeons show, that in many instances, vessels opened *into* the sac, if none were given off from it. When the aneurism has taken place from dilatation, it is possible that a vessel may be given off near its commencement, and blood yet pass through. When the sac is a preternatural enlargement, the circulation will go on through it and the arteries which arise from it. The preparation 411 H proves this fact in an admirable manner.

It is a portion of the descending aorta, affected by a preternatural dilatation, and by an aneurism. The preternatural dilatation is on the left side, looking at the preparation, the aneurism to the right. From the lower part of the preternatural dilatation the cœliac artery is given off, and is quite pervious. The superior mesenteric has an aneurismal dilatation at its origin, and a portion is turned back to show that it is formed of all the three coats of the artery. The aneurismal tumour opposite to it was in all probability filled up by coagulum.

The following preparations show the manner in which an aneurism is formed by the dilatation of all the coats of an artery.

No. 371 B. Michael Field, aged 43, was admitted, Aug. 12, into the Westminster Hospital, under the care of Dr. Roe. Has been a sailor ever since he was a boy, and addicted to drinking grog in large quantity, of which his face seems to bear testimony. About six

months back he first felt pain in his shoulder: two months after that it increased so much that he was obliged to give up work; and about eight weeks ago he caught cold from wet feet, and brought on an inflammatory attack of the chest, which ended in a purulent expectoration and a teazing cough, under which he became much emaciated.

On examining the chest, an aneurismal tumour was found pulsating immediately under the right clavicular articulation with the sternum, and the clavicle appeared to be partly dislocated. This tumour increased a little previous to the man's death, which took place from the affection of the lungs on the 3d of December. The arch of the aorta is preternaturally dilated, and there are four distinct aneurismal tumours to be observed: the largest is at the root of the arteria innominata. The arch of the aorta is opened to show the remaining three. The largest of them communicates with the posterior part of the large curvature by an opening of nearly a rounded form, being three quarters in its longest diameter, and is filled by a coagulum, which was quite soft in the recent state. This aneurism is within the reflected membrane of the pericardium, and the coats have been turned back to show the middle one to be that which is principally diseased. The two remaining aneurismal sacs are very small: they are on one side of the aperture of communication of the preceding one, and are separated by a distinct ridge. Attention was directed to them from their being filled with a layer of soft coagulum. The bottom of each little depression was an atheromatous patch, from which a curdy matter was readily

pressed out, showing in a clear and distinct manner the mode of formation of an aneurism of this kind, and the different stages between its commencement and the completion of that opening shown in the first of the three, which is precisely the same as that which Scarpa has attributed to a rupture. The aneurism of the upper part of the arch communicates, by a similar kind of opening, on one side and rather behind the commencement of the arteria innominata. It lay upon the artery, and could hardly fail to be mistaken, as it was in reality, for an aneurism of that vessel. This sac was filled by coagula deposited in concentric layers, and the wall was thin, the internal and middle coats not being traceable over it. A portion of the upper part of the sternum is preserved, in a carious state, to show the situation of the tumour, which could not have been distinguished from an aneurism of the innominata, and if it had been a single one, its state could not have been influenced by any operation on the subclavian or carotid arteries.

No. 372, of which a description is given in p. 53.

No. 397 A, see page 54.

No. 368, see page 32.

No. 369. The arch of the aorta removed, with a small portion of the heart, showing the semilunar valves, the arteria innominata, the left carotid and subclavian, and the commencement of the aorta descendens. The artery has been slit open from behind, to show a transverse opening, about three-fourths of an inch in extent in front, and half an inch before the innominata is given off. The coats of the artery are healthy, save where two or three small atheromatous

patches are situated near to the opening, which communicates with an aneurismal sac as large as a full-sized double fist, which pressed against the sternum and ribs; a part of the sternum being removed, with the cartilages of the second, third, and fourth ribs of the left side. The sac is evidently formed by the outer cellular coat of the artery, which has grown with its dilatation, so as to preserve an equal degree of thickness, save where it pressed against the sternum, at which place it has been completely absorbed. The edges of the opening are smooth and rounded, and a bristle is placed where the middle and inner coats can be seen passing over them, and from whence they may be traced for some little distance into the sac, with the fibrous walls of which they seem to be confounded. A part of the old coagulum is seen in situ, and its concentric layers are well shown. The aorta is not in the least dilated.

No. 365 shows a small dilatation immediately above the semilunar valves of the aorta, forming a cavity within, and a corresponding protuberance externally.

No. 7, dry. Shows the arch of the aorta considerably and preternaturally dilated, as well as ossified so as to be partly converted into bone. A small aneurism, capable of receiving the end of the finger, is distinctly seen below the origin of the left carotid and subclavian, resembling but being larger than the pouches in No. 394 in the same place.

No. 15, dry, is a preparation corresponding nearly in every point with 369, save that the aorta is preternaturally dilated from its valves to the origin of the arteria innominata. At two inches above the valves,

on the anterior part, an aneurism is situated, the diameter of which, from side to side, is two inches and a half, the opening of communication with the vessel being nearly circular and an inch in diameter, the edges of it well defined, and the coats of the artery very little diseased, and that by small spots of ossification. The aneurismal tumour is only half the size of that in No. 369.

No. 390, is a portion of the external iliac artery, with a part of a large aneurismal sac. There are two very distinct dilatations above it, showing the atheromatous disease, with an ossific scale between the internal and middle coats. The latter is thickened, and externally the outer and middle coats have been raised, to show that the inner coat is perfect, and uniformly dilated with the other two.

No. 399, is a part of the crural and popliteal artery, the latter having a distinct aneurism on one side, which has been laid open. A layer of coagulum adheres to its inner surface. There are three distinct small dilatations in the artery above, which seem to have been formed in consequence of disease between the inner and middle coats, both of which are dilated, the swellings tending to the same side on the larger aneurism. The preparations No. 397 and 398 are from the popliteal artery of the opposite side of the same individual.

Scarpa has insisted that an aneurism is ALWAYS formed in consequence of a rupture of the inner and middle coats of the vessel, and of the distension of the cellular sheath which surrounds the artery, and not by dilatation in the manner I have described; and for

his opinions on this subject, reference may be made to the English translation of his work by Wishart, which is in the library of the college, from pages 68 to 83. It is necessary however to observe, that Scarpa's account of the structure of arteries differs from that which is taught in the present day, so much as to render his description rather unintelligible to junior students. He considers an artery to possess only two coats, the internal and the fibrous, calling the elastic cellular one of ancient and modern anatomists a sheath; and not distinguishing between that which is now called the outer coat, and the cellular tissue which surrounds and attaches it to the *real sheath* of the artery.

The following passages, at page 80, which are his two first conclusions, appear fully to exemplify this part of his doctrine. "The erroneous opinion that the large arteries, and especially the trunk of the aorta, are as it were insulated, or covered only by a very fine membrane, adhering firmly to the subjacent muscular coat, and easily lacerated, has given rise in all probability to the belief, that the ulceration or rupture of the internal proper coats of the aorta could not take place, without this thin tense membrane covering the artery externally being likewise torn. Undoubtedly if this were the case, with regard to the external cellular sheath of the arteries, it would necessarily follow that the blood should be effused into the thorax and abdomen in every case of rupture of the abdominal or thoracic aorta. Indeed, we sometimes see this happen in practice, by the combination of some particular circumstances; for if unfortunately the rupture of the internal and muscular coat of the aorta happens in

such a point of the artery, where externally there is only a thin tense membrane closely applied to the aorta, instead of a corresponding soft cellular sheath, we see that this external thin membrane is likewise comprehended in the rupture of the proper coats of the artery, and that therefore sudden death takes place from the inevitable effusion of blood into some of the principal cavities, especially the thorax. Such is the case whenever the internal and muscular membranes of the aorta are ruptured in that portion of the artery included within the pericardium, which is only covered by a thin reflected layer of it. In this particular circumstance of place and structure, as soon as the proper coats of the aorta are ruptured, this thin membrane is lacerated at the same time, and the blood is immediately effused into the cavity of the pericardium."

At page 113, he sums up his observations; and I shall select the two first. "1. That this disease is invariably formed by the rupture of the proper coats of the artery. 2. That the aneurismal sac is never formed by a dilatation of the proper coats of the artery, but undoubtedly by the cellular sheath which the artery receives in common with the parts contiguous to it, over which cellular sheath the pleura is placed in the thorax, and the peritonæum in the abdomen."

Later pathologists, adopting a different language in regard to the structure of arteries, have given a modified description of Scarpa's process. The following sketch is transcribed from Bertin and Bouilland, page 129, Paris, 1824.

"When the internal and middle coats have been destroyed by a more or less extensive ulceration, the blood propelled against the outer coat gradually raises and distends it, insinuating itself around, and forming at last a tumour of larger or less dimensions;" and further on, "In case of destruction of the internal and middle coats, the external one alone sustains the lateral pressure of the blood, and when its opposition is overcome, it yields, and becomes distended, so as to form a sac in which the blood accumulates. This sac however yields at last to the continual distending power exercised upon it, ruptures or opens itself, and the sheath of the vessel prevents in its turn the effusion of blood. This sheath also yields in a similar manner, and the surrounding parts, of whatever nature they may be, concur in the formation of the sac.

"We have shown how the external coat, more extensile than the others, assists in the formation of an aneurismal sac; and reasoning on this principle, all that would be required to prevent its formation, would be to deprive the aorta of its cellular coat. It may be said that nature has herself made this experiment. The aorta has not in fact a cellular coat at its origin, but is strengthened by a reflection of the pericardium. The consequence is, that the destruction of the coats at this point is followed by a perforation, and the effusion of blood into the pericardium, and an aneurismal sac is not formed."

It is distinctly stated by Scarpa, by Bertin, and Bouilland, and they have been followed by all contemporary authors, that an aneurism cannot form at the root or in any part of the ascending aorta, in conse-

quence of the want of cellular structure, which does not there exist. This, which seems to be an important part of the theory, is at once overturned by No. 367 of Mr. Hunter's collection, which is perhaps the finest preparation of the kind in existence.

It shows an aneurism of the very commencement of the aorta cut open. The semilunar valves, bounding the edges of the opening for the admission of blood from the heart, are distinctly seen forming a part of the wall of the sac, with the orifice of one coronary artery, which is situated in the only part of the aorta that is not dilated, being a portion of about half an inch in width and one inch in length, extending upwards, when the vessel resumes its natural appearance of ascending aorta. The aneurismal sac arising from this small portion of the artery is dilated downwards for five inches in length, and at least four in its different transverse diameters, forming a cavity when distended twice as large as a common-sized fist. It adheres firmly to the side and posterior part of the right ventricle, and extends even to the diaphragm, to which it adheres by a broad attachment. The internal surface of the sac around the valves, and on the opposite side, has evidently suffered from that disease which gives rise to atheromatous patches; and the inner membrane can be seen distinctly passing over them, leaving no doubt of the tumour being a dilatation of the coats of nearly the whole circumference of the artery. At the bottom part of the sac near the diaphragm, there are some remains of concentric layers of coagulum, and the inner coat seems wanting. There is no history belonging to this unique preparation. It com-

bines nearly all the characters of a preternatural dilatation, a very small portion of the circle of the artery not being dilated. The commencement of the sac, and for at least two inches or more, is decidedly formed of all the coats of the vessel, constituting what is called a true aneurism; and I believe that the disease of the inner coat, or its removal, led to the formation of layers of coagulum below, constituting that part a false aneurism.

This preparation proves the fallacy of the preceding observations, which have hitherto been received upon opinion rather than on proof. It has been supposed by all authors, who have written on aneurism, that it never took place immediately above the sigmoid valves, because there was no cellular structure at that part which might form a sac; and the artery being covered only by the reflected inner and serous membrane of the pericardium, must always rupture and not dilate. It has also proved, that an aneurismal sac is formed by a new growth of the proper external coat of the artery, and that it owes little or nothing to cellular structure, where little or none is supposed to exist. Taken in conjunction with 368, page 32, showing a rupture of a neighbouring part of the ascending aorta, and 396, showing an aneurism in the same situation, it proves that the cause which decides whether the artery shall be ruptured, or become aneurismal, has nothing to do, as has hitherto been supposed, with its cellular covering, or whether it has one or not; but on the nature of the disease which has taken place in the artery.

In regard to the two other conclusions of Scarpa, it

is necessary to advert to his remarks on brachial aneurism from a wound; when the advantage which he has derived in argument, from the very general view which he takes of the external cellular coat of an artery, will be at once perceived. Page 167, section 5, he says:

"The proximate cause, therefore, of the aneurism which is formed in the bend of the arm after venesection, as also that which occurs in the brachial or axillary artery, produced by a wound, may *invariably* be traced to the incision or solution of continuity of the two proper coats of the artery, and the consequent effusion of blood into the cellular substance surrounding the injured artery. The effect is the same, whether from an internal morbid affection, capable of ulcerating or corroding the internal and fibrous coats of the artery, the blood be effused into the neighbouring cellular sheath surrounding the artery, which it raises after the manner of an aneurismal sac, or, the wound of the integuments having closed, the blood issue from the wounded artery, and be diffused on the surrounding parts. The solution of continuity in the integuments, cellular membrane, and aponeurosis covering the artery, consolidates quickly in these cases; while, on the contrary, the proper coats of the artery remain separated at the place of the puncture or wound; and therefore, as was observed by Hildanus and Senertus, the arterial blood not finding any longer a direct way to spring outward through the integuments, infiltrates, as in the internal aneurisms produced by the ulceration or corrosion of the internal coat, into the cellular substance, covering externally the wounded artery,

and fills it in the manner of an *ecchymosis;* it then distends and elevates it in the form of a tumour, and the cellular divisions being destroyed, converts it at last into a firm capsular or aneurismal sac."

The advantage of not having distinctly defined what he understood by the external elastic cellular coat is plain. He alludes to it indifferently as a whole. Now when an artery is cut, not only is the loose cellular tissue divided, which Monro, as Scarpa observes, calls the "external loose cellular," but his "cellulo-membranous" coat is also cut as well as the fibrous and internal coats; and the blood projected through this "cellulo-membranous" coat may be caught and retained by the external loose cellular so as to form an ecchymosis; but it is a very distinct kind of ecchymosis from that which would have been formed in the same artery, if the fibrous and internal coats had been ruptured through disease. In this case the cellulo-membranous coat (according to the French writers) would have formed the sac. In the case of wound, it was the loose cellular tissue exterior to it and connecting it with the sheath. Scarpa contends that the aneurism is formed in the same manner in both instances, which is most assuredly not the fact. The force of these and other objections have been so strongly felt by continental and other authors, who have admitted that he may be wrong in some instances, that they have ventured to say, he must have drawn his inferences principally from external aneurisms, and not from internal ones. I shall not presume to say so much; but I must remark, that he seems to have seen all things with one view, and to have had the happy

talent of making every thing suit his purpose, whether it really did so or not; and this too (I desire to be understood) with the most honourable spirit and intention. I shall adduce as an instance of it, his manner of settling Dr. Monro's case, which he copies from the Edinburgh Essays and Observations: see page 118, et seq. There were three small aneurisms of the femoral artery, and one large one of the popliteal. The parts were carefully dissected, and Dr. Monro's account is as follows.

"The aneurismal sacs you sent to Edinburgh were dissected by your brother in my presence: the appearances were the following. The external loose cellular, and the cellulo-membranous coats being dissected away carefully, the circular fibrous, commonly called muscular coat, was evidently seen continued on all the three small sacs in every part of them, but was thicker there than in the sound part of the artery. And what is worthy of the greatest attention, in the most enlarged part of the sacs, an extraneous substance, resembling a soft steatomatous matter, was intermixed with the muscular fibres. The cellular substance lining the inside of the muscular coat was considerably thicker than natural, and had much the same appearance of an extraneous substance filling its cells. The internal membrane of the artery adhered so firmly to these cells, that it could not be separated, but seemed thicker than in a sound state. Though the circular fibres could be observed at the sides of the incision made into the fore part of the sac of the left ham, as represented in your figure, yet, as the dissection was continued backwards towards the most distended part,

these muscular fibres became less observable, and could not be traced. Whether this apparent defect of them here was owing to a much greater proportion of the extraneous substance above mentioned, or to their having been destroyed by the great distension, is difficult to determine. The internal cellular coat of this sac was considerably thicker than in the smaller ones, but of the same texture. The most internal membrane was in a thickened adhering state. In the part of the great sac of the right ham which came to Edinburgh, no circular fibres could be seen, and the structure was otherwise much the same as that now described of the back part of the sac in the left ham."

This dissection, any one might reasonably suppose, would have satisfied Scarpa that he was in error, and that a dilatation of all the coats of an artery might take place; but he took a different view of the question, and settled the matter very calmly in favour of his own opinion, by stating, that the thickening of the coats of the vessel had "*rather diminished* than enlarged the natural diameter of the artery." Now this is a mere gratuitous supposition, unsupported by proof, and indeed disproved by the very words of the case; yet Scarpa fully believed that he was right, and has actually represented the three small aneurisms *unopened* in his ninth plate.

That a steatomatous or atheromatous state of the middle coat of an artery of moderate dimensions, such as the femoral, does occasionally cause an internal projection capable of diminishing the diameter, or of altogether filling up the canal of the artery, has been said to take place by Monro in his works, and may be

seen in some preparations in the Museum; but that this disease should at the same time give rise to a tumour resembling during life and after death an aneurism, has not been satisfactorily demonstrated, and certainly receives no support from the preceding observations.

There are many very fine preparations in the Hunterian collection, which appear at first sight to support the opinion maintained by Scarpa, that a rupture takes place of the inner and middle coats of the artery in cases of aneurism; but a careful examination of them rather leads to a different conclusion. The oval, rounded, and even fissure-like opening would naturally seem to be the result of a rupture, such as has been described under the head of a dissecting aneurism, at page 43; and it is by no means intended to deny that this accident may occur in some instances. I have seen the inner coat, and even the middle one ruptured, in cases in which these parts had been previously softened by inflammation. The appearances observed on the dissection of the body of His Majesty George the Second are a proof of the occurrence, if others were wanting. Nicholls says, a fissure was found on the inner side of the trunk of the aorta, about an inch and a half long, from which some blood had recently passed under its external coat, and formed an elevated ecchymosis. These fissures or rents are usually found to take place in the circular direction of the artery, and in the course of the semicircular fibres of the middle coats, which may possibly account for their looking as if cut by a sharp instrument. They have been, although rarely, met with running in different

directions; and when the parts have been ruptured irregularly, the rugged edges have been supposed to adhere to the outer coat, or to be gradually rounded off by time, so as to form the smooth round or oval opening, which is so frequently seen to be the means of communication between an aneurismal sac and the canal of the artery. Yet the gradual formation of this oval or rounded opening may be so easily traced from the atheromatous patch to a complete hole or fissure, that the evidence appears much more complete in favour of the dilatation followed by absorption of the inner and middle coats in internal aneurisms, than it is in favour of a rupture of them in the first instance. The last part of the argument, *viz.* whether these coats, and especially the inner one, do or do not pass over the rounded edges of the opening, is an appeal to a fact which appears to be more easily demonstrable than it really is; still the preparations alluded to seem to demonstrate the fact in most instances in which they have been examined, or only to leave it doubtful from the point not having been sufficiently attended to. The truth is, that the subject has not yet been satisfactorily investigated; and the authority of Scarpa has perhaps hitherto prevented due inquiries being made, so as to leave, from a multiplicity of observations, no doubt of the real nature of the case. The preparations 388, and 367 A, deserve attention, being instances of the doubtful manner in which the aneurism has been formed.

No. 388. A portion of the aorta, and a small part of a very large aneurism. The opening of communication is oval, as if taken out with a punch. The vessel

anteriorly has little or no appearance of disease or of dilatation.

No. 367, A. Aneurism of the aorta ascendens, which protruded to a considerable extent on the outside of the sternum. The artery begins to enlarge immediately above the sigmoid valves, which are not diseased, and it does so in every direction, although much more towards the anterior part. The enlargement ceases at the origin of the arteria innominata, which, with the orifices of the left carotid and subclavian, are diseased, but the canals are not diminished in size. One half of the tumour has been cut off with the external parts, and this half is seen filled with coagula, so as to destroy the appearance of a cavity. The part remaining is a preternatural enlargement of the aorta ascendens, the circular opening at the sigmoid valves being four inches from the circular opening of the artery, where the left subclavian is given off. This sac is composed of all the three membranes or coats: the inner one is covered with calcareous deposits, and eaten away in various places by ulceration, as if honeycombed. These spots were certainly atheromatous or steatomatous patches, destroying the inner and middle coats. This part of the sac contained no coagula, and appears to have been continuous with the other by the giving way of the upper side of the arch in its largest curvature, for an extent of nearly four inches. The edge of the dilated part is defined, and distinctly seen: the inner coat passes a little way beyond it, is then lost, and the concentric layers of coagulum begin. It is probable that the longitudinal yielding took place when the sac touched the sternum.

A portion of the concentric coagula belonging to the other half of the preparation is seen, as if commencing; and where a portion has been removed, the sac or wall is much thinner than within the opening. The greater firmness or ridge, where the natural coats terminate and the false aneurism begins, forms a sort of constriction between the tumours.

When an aneurism is formed through the rupture of the internal and middle coats, and the distension of the outer coat of an artery, it is called a *false* aneurism. When a *true* aneurism is formed by a dilatation of all the coats of an artery, and after attaining to a definite size suddenly increases at one spot, so as to give the tumour the double appearance of one swelling above another, it is usually called a *mixed false aneurism.* When the upper tumour is examined, the communication between the two will be distinctly seen, forming really an opening, which may be caused, either by absorption, or by rupture after the manner described by Scarpa.

The inner coat has been said to protrude between the other two, and to form a sac of an aneurism, called *mixed internal.* It is said in France, that such a case was seen, and the preparation was presented to the academy at Paris, by Professors Dubois and Dupuytren in 1804; but Boyer, who published in 1818, denies the existence of a disease of this nature; and although the experiments of Haller, who removed the two external coats of the mesenteric arteries of pigs, and saw the inner one dilate into an aneurismal bag, would seem to support the opinion that such a disease might occur, the counter experiments of

Mr. Hunter, Sir E. Home, and Scarpa, prove the reverse, the inner coat either yielding by rupture, or becoming firmer by the granulations which arise from its surface, and from the adhesion of the surrounding parts. Further experiments have however proved, that when the artery has not become consolidated and impervious by this process, it is liable to the formation of an aneurism by the gradual dilatation of the part of the artery on which the cicatrix has taken place, forming a kind of true aneurism. I once saw an instance of this in an officer at Badajos, who had been wounded in India by an arrow, which injured the carotid artery at its bifurcation. A small pulsating swelling was observed at the spot some months after the accident, which very slowly increased until it had attained the size of a pigeon's egg, when I first saw it. He considered it to be gradually getting larger, and had determined to have a ligature placed on the main trunk at the end of the campaign; but a ball, which unfortunately went through his head at the battle of Vittoria, deprived me of my patient, without giving me the opportunity of ascertaining the exact nature of the disease. I consider it to have been a dilatation of the artery, and not a tumour arising from the extravasation of blood under the deep cervical fascia, which would have shown itself earlier. It is probable that the three coats of the artery were wounded, but not to a sufficient extent to prevent their reunion.

It is only under certain states of disease that the external coat of an artery will admit of the dilatation necessary for the formation of an aneurism, even with the additional support which it obtains by adhering

to the surrounding parts, and by an additional growth. These particular or certain states have not been hitherto sufficiently distinguished, and all kinds of disease affecting the vessel have been considered equally capable of causing an aneurism. It is more than probable that this is an error, and that its formation depends on one or more kinds of disease, and the occurrence of rupture to another. It is not intended to say that all these different species may not be occasionally present together, but that the nature of the result will depend on the greater prevalence of one than of the other.

These observations will perhaps receive some support from what is observed in external aneurisms, particularly in the ham and thigh. In these the aneurism is usually the result of disease, which is often confined to the vicinity of the part, although it is sometimes the consequence of a general aneurismal diathesis. But when the disease is the result of an accidental affection of the part, and the tumour has increased to some magnitude, the external coat does not usually form the sac, having been ruptured at an early period. Blood is effused around the ruptured artery, and the surrounding parts becoming in some degree consolidated, constitute a sort of sac, which is more or less defined.

This kind of aneurism is called *a spurious external circumscribed, or diffused aneurism*, as the case may be of circumscription or diffusion. On examination, the ruptured part of the artery is readily distinguishable, and a portion of the artery is usually deficient, for nearly, if not the whole of its circumference. It will be found

altered in structure for some distance above and below the immediate seat of the aneurism, and as generally affected by atheromatous or steatomatous patches, rather than by the cartilaginous and calcareous deposit; unless in cases which seem to have depended on a general aneurismal diathesis, when either or all kinds of disease may prevail.

When an artery is wounded, and the external opening in the integuments closes so as to prevent the blood flowing through it, a *traumatic spurious external circumscribed or diffused aneurism* forms, according to the facility which happens to offer from the structure of parts for the confinement or diffusion of the extravasated blood. But this traumatic spurious aneurism differs materially from one which has taken place spontaneously, or as a consequence of disease, and not of immediate injury. In the spurious aneurism from disease, the artery is in general unsound for some distance above and below the tumour. In the aneurism from a wound, the artery is perfectly sound, except as far as concerns the injury, and no effort is yet making by nature to obliterate the artery below or beyond the aneurism, which frequently takes place when it occurs from disease. There is not only a great and essential difference in these two kinds of aneurism as regards their nature; but also with relation to the collateral circulation, and the operation to be performed for their cure; — points of great importance to be discussed hereafter.

The late Mr. Shekelton has pointed out in the third volume of the Dublin Hospital Reports another kind of aneurism which had not been before no-

ticed. It appears to have been at first of the nature of the dissecting aneurism, described page 43, but with this addition, that the blood, after having forced its way through the inner and middle coats of the vessel, not only dissected the middle from the outer coat for the space of four inches; but then again forced its way into the canal of the artery, through the middle and inner coats; forming as it were in this manner, and at this particular part, two channels for the passage of the blood to the extremities. He met with this state of disease in two cases, and says—

"In these cases of aneurism the disease seemed to have commenced in the way it usually does in large arteries, by a dilatation of the inner and middle coats, as was observed in the aorta of the second case; a section of the vessel, which was accidentally made, showed that the blood did not equally protrude all the coats, but rather detached the cellular from the middle one, and thus endeavoured to pass along the side of the vessel, which it might have done to a greater extent, were it not that the sac gave way; the blood forcing on made a passage in the artery, the internal and middle coats of which having afforded less resistance than the cellular.

"The blood having thus found a free passage, the over distention of the sac was taken off, and a new change commenced; the sac became lined with lymph, and assumed a smooth surface, and was now capable of resisting the force of the circulation; the rent in the artery enlarged, and the greater portion of the blood passed through its new channel; the original vessel, compressed by the tumour, had its direction

altered, and that of the new formed canal assumed its place.

"In these aneurismal sacs then, we have sufficient evidence of their capability to contract and resist the pressure of the blood, when the force of the column is sufficiently diminished; and that the powers of restoration in the sac are fully competent to make it a new and perfect channel for the blood, when the irritation arising from over distension is removed; but that such will be the case in every instance of this form of aneurism, is more than can be expected."

In conclusion, I will venture to suggest the following arrangement of the several species of diseases, and their consequences, as deserving some attention from future observers; aneurism having hitherto been considered to be equally a consequence of all.

1. That a *preternatural enlargement* may exist with a natural appearance of the coats of the artery, subject in all probability to the loss of a part of their elasticity. In some instances, the coats of the artery are thinner than usual, principally at the expense of the middle coat; but in the generality of cases the external and middle coats are thicker, and the inner coat softer and more easily detached than is usual from the middle coat. When appearances of more positive disease show themselves, which is not always the case, they are the atheromatous, or the whitish or cartilaginous patch, attended by calcareous deposits in spots and scales, which latter more frequently lead as the disease advances to the honeycombed appearance of the inner membrane from ulceration, as in

367 A, page 78.

2. *True aneurism* is more generally the consequence of the atheromatous or steatomatous disease affecting the middle coat. It may be combined with a cartilaginous state of the artery, and is not free from calcareous deposit; but the two latter appearances are not sufficiently marked to give the same character to the disease as in the preternatural dilatation.

3. It is difficult to explain in what the difference consists, which exists between the state of the internal coat in *preternatural* dilatation and in *true* aneurism, so that the blood does not coagulate in the former, whilst it is deposited in concentric layers in the latter.

It is possible that it arises from an excess of refinement in the distinction between the two diseases, and that there ought not to be, and perhaps there is not at a late period, any difference between a preternatural dilatation, bulging to one side of the artery, and a true aneurism, a state which is remarkably well shown in No. 411 H, page 62. At all events, preternatural dilatations of a large size, and departing from the course of the vessel from which they arise, do generally lose their distinguishing character of freedom from concentric layers of coagula, so that the distinction between them, under these circumstances, is lost.

4. A *false aneurism* is formed through the rupture of the internal and middle coats of an artery followed by the dilatation of the outer one; or may be merely an advanced stage of a true aneurism, in which the inner and middle coats have been distended or affected at one part, so as to have been removed. This may also take place with the outer coat, in which case the cellular sheath forms the aneurismal sac. In the same

manner this may be afterwards removed when it comes in contact with bone; subsequently the bone itself is absorbed, leaving only the superficial fascia; and ultimately the skin as its external boundary, the removal of which gives rise to death by hemorrhage. This kind of aneurism has also been called *consecutive or external mixed false aneurism.*

5. A *rupture* of the whole of the coats of an artery does not depend on the absence of a cellular sheath, or the non-interposition of a sufficient quantity of cellular tissue between the external elastic coat of the artery, and any superficial covering which it may receive from the inner serous membrane of the pericardium, the pleura, or the peritoneum; but on a particular disease of the artery commencing with the middle and inner coats, which leads to ulceration and rupture, and not to distension. The opening may be either a rent or a hole of various dimensions. In parts where there is a quantity of cellular tissue it may yet form a *spurious* aneurism. In other parts it gives rise to death by hemorrhage.

6. An *aneurism* in young persons is generally the consequence of some accidental injury or disease of the part in which it is situated, and of which the rest of the arterial system does not partake. A *preternatural enlargement* is more common to elderly persons, and is usually accompanied by a general derangement of the arterial system, and frequently by aneurism.

Causes.

The predisposing causes of internal aneurism, or of disease generally in the coats of arteries, are unknown.

The effect is seen, and the immediate cause is in all probability chronic irritation or inflammation. The predisposing cause has often been attributed to the effects of syphilis, or mercury, or both; but I do not believe that there is any solid foundation for the opinion. So many persons have all the different diseases to which arteries are liable, who have never had the disease or the antidote, and so many have had the lues venerea and taken large quantities of mercury, without suffering from more disease of the sanguiferous system than their neighbours; that it does not appear to me philosophical to admit such a predisposing cause, merely because the poor who enter hospitals have been found in many instances to have suffered from both. Women are less liable to internal aneurisms than men, but not in the proportion usually attributed to them. The difference in external ones, and particularly of the lower extremities, is certainly remarkable. I do not recollect having seen more than three women suffering from popliteal aneurism; and it is probable that they are found on an average at least from twenty to thirty times in men for once in woman. The structure of the vessels is the same, but the mode of life is different. The exertion in general is infinitely greater in the man than in the woman; and I think this, combined with the freer use of ardent spirits, a much more likely predisposing cause than either syphilis or mercury.

In many cases of external aneurism, and particularly of popliteal, the commencement of the disease is often referred to a greater exertion than usual, although of a similar nature to that commonly made; or to an accident. Postboys, postillions, and persons

of that description, have long been supposed to be more liable to popliteal aneurism than other men, from the constant motion given to that part of the artery in riding. In one case of aneurism of the femoral artery in a cobbler, it could be fairly traced to the stone which he placed on the inside of his thigh to beat his shoe soles upon, from the jar of which he felt uneasiness for some time before the tumour formed. In another, a heavy dragoon received a violent jerking blow from the crupper of his comrade's horse, whilst both were in the act of wheeling in different directions, which gave him great pain. On the evening of the second day he felt an extraordinary throbbing in the part; and on the fifth day he presented himself to Mr. Bett, the assistant surgeon of the regiment, who recognized an aneurism the size of a pigeon's egg. A ligature was placed on the femoral artery on the 3d of November, which came away on the 24th. The operation was performed seven weeks after the accident; and the man has remained well now three months since he was discharged the hospital.

Termination and Spontaneous Cure of Aneurism.

The manner in which an internal aneurism proceeds by rupture, ulceration, or sloughing, to its termination by the death of the patient, has been already shown. In external aneurisms, the ulceration and sloughing of the tumour will also take place, if not prevented by art; and when they do occur, death is not the inevitable consequence, as will be hereafter shown. The present object is to explain the ways in which an

aneurism may proceed to its cure by the efforts of nature unassisted by art. They are supposed to be three, *viz.* 1. By coagulation of its contents. 2. By sloughing. 3. By an accidental pressure of the sac upon the artery.

1. *By coagulation of its contents.* The opinion now entertained of the nature of the difference between a preternatural dilatation of an artery and an aneurism, nearly precludes the possibility of a cure being effected in this manner in the preternatural dilatation; and, provided the theory be true, confines of course this mode of cure to aneurism. In the preternatural dilatation it is presumed that there is little or no coagulum formed until the approach of death, or until the inner membrane has been in part removed; but in aneurism a soft coagulum is formed as soon as the dilatation is distinctly marked, and coagula are soon deposited in concentric layers, which frequently fill up a considerable part of the sac, and in some instances nearly the whole. Where the artery is large and the current of blood rapid, as in the aorta, a small coagulum falling into the canal of the vessel could hardly resist its impetus, or if it did, it would produce nearly instant death. The aorta is therefore never obliterated by this process, but by the slower one of inflammation of its internal coat, effusion of coagulable lymph, and narrowing of the canal; accompanied by a concomitant enlargement of the collateral vessels, so that the circulation may be carried on when the artery is obliterated. This has been known to take place in the aorta, and is the common course of proceeding in every other artery that has sustained an injury, or in which

inflammation of an acute kind has been set up. In smaller vessels in the extremities, which are not kept clear by the rapidity of the circulation, two natural processes favouring the cure of aneurism by coagulation have been observed to take place. The *first* is the enlargement of the collateral branches to such extent, as to enable them to maintain the circulation, if the main trunk be suddenly rendered impervious. The *second* is the effort made to close or shut up the lower openings from the aneurism, or those most distant from the heart. An effort which has been hitherto scarcely considered as a natural one, but which is frequently attempted and often with success.

In a case of inguinal aneurism in the Westminster Hospital, in which Mr. White operated by placing a ligature below the tumour, the artery, when laid bare, was not distinguishable by its pulsation. No blood appeared to pass through it. It was selected by Mr. White from his anatomical knowledge of its proper situation, and a ligature was placed upon it previously to its division, when its canal was seen to be contracted to one quarter its natural size: the coats of the vessel were greatly thickened. It made a strong impression on every one present, that the ligature would do little more than excite inflammation; which took place, and the case terminated unfavourably from sloughing of the aneurismal sac, which was materially assisted by a bad constitution.

The opportunity of examining this part of an aneurismal artery is of rare occurrence; but the Hunterian collection supplies several instances of all the openings into an aneurism, save the upper one, having been closed during life; and I think in sufficient number

to establish the fact, that in aneurism of the extremities nature resorts to this method as a part of the curative process; and that although she succeeds in effecting it, still more is requisite to complete the cure by the filling up and obliteration of the tumour. These preparations also show, that when the lower end of the artery has been obliterated, the aneurism has not ceased to increase. It is a step, which, when once taken or even begun, favours the coagulation of the blood; and if a piece of coagulum be separated by accidental violence or other irregularity committed on it by the patient, or by a state of syncope supervening, or by any other means, the coagulation of the whole of the fluid blood in the tumour may rapidly take place. I suspect however that this process is more complicated than is usually supposed, and that much depends on the nature of the disease in the coats of the vessel which has given rise to the aneurism, as well as on the state of the blood. When the blood in an aneurismal tumour is coagulated in consequence of the impetus and supply from above being nearly or completely cut off by ligature, the ultimate non-obliteration of the sac is so rare an occurrence as never to be expected to take place, although it may be and often is delayed for a considerable time. It seems to me equally certain, that the cutting off the passage of blood through the lower or further end of the tumour, neither places the sac nor the blood in it under similar circumstances; and that the same processes cannot be expected to occur, unless under particular circumstances which are not at present understood. For instance: it does not appear that the

coagulation of the whole of the blood in an aneurismal tumour is the necessary consequence of the closure of the lower opening; and that as long as this coagulation does not completely take place, and the impetus of the blood remains, the tumour will go on increasing. Its increase may receive a momentary check from the closure of the lower opening, but more is required to complete the cure. This subject will be further considered hereafter; at present it will be sufficient to refer to the instances in the Hunterian collection, in which the lower or further extremity of the artery was closed by nature, without producing a beneficial change in the aneurism. (See No. 386, 392, and 397.) Others are to be met in almost every author who has written on the subject, as well as in many cases which have been published separately; but the occurrence has always been considered as accidental.

No. 386 is a part of the brachial artery, with a portion of the aneurismal sac, which was in the axillary artery, the upper part of which is shown in 385. The part of the brachial artery is filled by coagulable lymph.

No. 392 shows a small portion of an aneurism of the popliteal artery: a bristle is placed in the upper orifice: the lower was obliterated.

No. 397. An aneurism of the popliteal artery. The surrounding parts are left, to show their relative situation. The femur and tibia are sawn through obliquely. A portion of the sac is removed, and the artery is laid open above and below it. The artery, before it enters the sac, is for some way very much contracted, and

especially at its orifice. The lower opening was closed, and no injection passed out when the parts were injected after death. It is therefore probable that no blood passed out during life.

Nothing is more simple than to say that the blood coagulates in layers, or as a whole, until the sac is filled with it; when nature considers it as an extraneous substance, and employs the absorbents for its removal until the artery is rendered an impervious ligamentous cord, having attached to it a small hard fleshy tumour, which was the aneurism. It is more difficult to explain why this does not always take place, than why it should occur in particular instances. In these cases of spontaneous cure, accompanied by obliteration of the artery, in which dissection has enabled us to ascertain the state of parts, it has always been found that the coagulum of blood was continued into the upper portion of the artery. It is possible, that nature having in some instances closed the lower opening of an aneurism, endeavours to do the same with that nearest the heart. It is perhaps this effort which gives rise to the formation of the coagulum which fills the tumour; an effort which must always be opposed by the impetus of the blood, unless the coats of the artery take on that higher degree of inflammatory action which leads to effusion on the inner membrane, and the establishment of a power capable of resisting the force of the blood, when the spontaneous cure would be effected. It is very likely then, that the spontaneous coagulation of the blood in an aneurismal tumour is accompanied by a

change in the action going on, either in the artery or in the walls of the sac, or in both.

When an aneurism of the aorta has been known to have undergone a spontaneous cure, and which is of rare occurrence; it has usually been one which communicated with the canal of the vessel, by an opening apparently less, or not more than an inch in diameter; through which the blood might perhaps pass with less impetus, being nearly at a right angle with its course. The cure however is accomplished by the deposition of coagula in concentric layers, one within the other, until the whole sac is filled up, when the disposition for further deposit ceases. The last layer assumes more of a smooth membranous appearance than the others, and does not seem any longer to offer an attraction capable of causing the blood to adhere to its surface, or to be deposited upon it. It does not generally restore the cylinder of the vessel to its natural state, but leaves at that part an evident hollow, indicative of the sac which previously existed. This method of cure may and has been known to take place in arteries of various sizes, but it is more common in all smaller ones for the vessel itself as well as the sac to become impervious.

It is difficult to explain in a satisfactory manner, why, in two cases as nearly similar as possible, one aneurism shall terminate in a spontaneous cure, the other go on enlarging until it bursts, or yields by sloughing. Why an aneurism shall remain nearly stationary for several years, and then increase most rapidly. Why the layers of coagulum or fibrine in one shall be firm and fleshy,

and adhering to the sac, whilst in the other they shall be soft, pliable, partly decomposed, and allowing the blood to penetrate between them and the sac, until at last it makes its way to a surface from which it may escape, giving rise to a fatal hemorrhage. It is probable that this does not depend on the impetus of the blood alone, but on its chemical nature and properties, influenced by the kind of action going on also in the sac itself. It has been supposed, that where two aneurisms exist in the same vessel, the cure of the lower or more distant one might take place in consequence of the diminution of the impetus of the blood, from the passage of a portion of it into the upper one. It may be permitted to doubt this opinion, as well as another which has been entertained, *viz.* that it is the force of the circulation *alone* which causes the enlargement of the sac and its ultimate rupture. It might as well be said that it is the force of the circulation alone which gives rise to aneurism.

That the superior aneurism may have some influence on the circulation through one situated below it, is not disputed; but the fact of a man having once had as many as sixty-three aneurisms in the arteries of his trunk and extremities, very much invalidates the supposition of a cure being effected through its means alone; and the dry preparation, Mr. Chandler's donation to the Museum, shows the little influence which such a state exerts in the aorta.

There is a large aneurism of the commencement of the descending aorta, extending upwards and backwards, causing the absorption of the second, third,

fourth, fifth, and sixth ribs. The fourth and fifth dorsal vertebræ are carious, and the aneurism forced its way into the spinal canal at that part. A second large aneurism, six inches long and three wide, exists on the anterior part of the aorta, commencing opposite to the seventh dorsal and terminating at the first lumbar vertebra. A part of the bodies of the tenth and eleventh dorsal vertebræ have been absorbed: the intervertebral substance remains.

This preparation shows the manner in which the bodies of the vertebræ are removed by progressive absorption, whilst the intervertebral substance, like the fixed cartilages, being less resistent and more elastic, yields to the impulse and avoids that process; but not from its possessing fewer absorbents, a set of vessels, which, although they cannot be demonstrated in cartilage, are yet seen from their effects when inflammation and suppuration take place.

The removal of the bony wall on one side of the spinal canal by the superior aneurism, which penetrated into it, renders this preparation unique in England. An instance of a similar kind is recorded by Laennec, and is considered on the Continent to be the only one known.

2. *By sloughing.* The spontaneous cure of an aneurism by its removal through sloughing or sphacelation was known to the earliest authors on the subject, although it is of unfrequent occurrence and dangerous in its nature. Severinus, Lancisi, and Guattani, each give instances in which it took place. The only cases I have seen were in the groin, and three in number: others have been observed in the ham as well

as in the groin, but the process in all is the same. The best case which I know of recovery by sloughing was in the instance of a soldier under the care of Mr. Albert in the York Hospital. The tumour was of a large size, and extended above as well as below Poupart's ligament. It pulsated violently: the walls were thin, the surface inflamed. At last the integuments on the apex of the swelling became of a livid colour, pulsation ceased, and the whole tumour became black and flaccid. A small opening formed in the centre, from which fetid coagulated blood issued. The mortification extended around the circumference of the tumour in every direction, and beyond it, until the whole sloughed out. Several pounds of coagulum were discharged, after which the surrounding parts began to take on a healthy action, granulations sprang up, and the part ultimately healed.

In the other two cases which I have mentioned, the patients both died; not however during the sloughing process, but subsequently, being worn out by the continuance of the discharge, and the irritation arising from the ulceration having extended to the hip joint. The artery was obliterated above and below the ulcerated part, and was deficient in the situation of it. It is fair to suppose, that both these patients would have recovered, if ulceration had not implicated the ligamentous structure of the hip joint. Mortification is however so dangerous and uncertain a process, so prone to recommence when it has become stationary, and to spread again with the greatest rapidity, that the attempt at a cure by sphacelation must always be

viewed with the greatest anxiety, and if possible be anticipated by the necessary operation, when situated in parts admitting of its performance. *The operation should never be had recourse to after mortification has begun.* If the patient dies of the mortification, the operation is useless; and if he survives it, the operation is unnecessary; for the artery must and will be obliterated for some distance above the aneurism, by the process of inflammation, which necessarily takes place in the separation of the dead parts from the living; and it may, by inflicting an additional injury, prove destructive.

3. *By an accidental pressure of the sac upon the artery.* When an aneurism is situated near the trunk or branch of an artery, distinct from that to which it owes its origin, it has been known to increase in size until it overlapped and pressed upon this neighbouring vessel; and this pressure has given to rise to a degree of inflammation in its coats sufficient to lead to its obliteration. Several instances are recorded in which such an occurrence took place; and it has led to the supposition, that an aneurism might, by enlarging in a particular direction, press on its own trunk in a similar way, and prove thereby its own antidote and cure. This is possible, but I have not met with a case in which it occurred, neither has it been proved by dissection to have taken place. It is then a theoretical opinion as to the manner in which a cure of aneurism may be effected.

I have also some doubts of its ever occurring in the way described. An artery pressed upon in the manner stated will always yield, unless it is pre-

vented by the vicinity of unyielding parts, in which case it is exposed to a double pressure, under which alone it is my belief that its obliteration will take place. There are several preparations in the Hunterian collection, which show that different arteries must evidently have suffered considerable compression, under which they have altered their direction, but there is only one in which the artery has been obliterated: it is No. 381, an aneurism of the left carotid.

The larynx and trachea, with the thyroid gland, are distinctly seen: the tongue remains in situ. The aneurismal sac extends upward as high as the level of the under part of the tongue, and downward it rests upon the thyroid gland, being as large as a good-sized orange. It is laid open in front, to show the coagula with which it is lined in every part, save in one small spot not more than one-eighth of an inch in width, which seems to be the remains of the artery, the lower orifice of which is seen immediately as it comes off from the common carotid: a bristle has been introduced into the artery where it is cut off on the upper edge of the preparation, and has been carried through the upper orifice in the sac, which is quite close to the lower one into it, and from thence into the common carotid. On the posterior part, the carotid is laid open, and about an inch above where the external one is given off, the internal, or continuation of the common trunk, is obliterated for nearly one-eighth of an inch in extent, as if a ring had been formed at the part. The transverse ridges of the inner coat of the artery are more distinct, and it looks as if it had been the seat of inflammation, caused in all probability by

the pressure of the sa cupon it, which must have been very much confined in this particular situation.

I have never seen a case of a spontaneous cure after an artery had become dilated, so as to form an external aneurism, the canal continuing pervious. The following case, which has been given to me by Mr. Rae, a surgeon in the royal navy, would seem to show the possibility of such an occurrence taking place. I have seen instances, and have one under observation, in which an aneurism of the subclavian artery has greatly decreased in size, the canal being perfectly clear, but the result is very uncertain.

"In November, 1827, at Sydney in New South Wales, an active and healthy young man, about twenty-eight years of age, had been complaining for several days of pain and swelling in the right groin, which was attributed to a sympathetic affection of an inguinal gland. No notice was taken of it until the Sunday following, when I went on shore to accompany him to church. He then complained more of the pain and swelling, and had some difficulty in walking. I requested him to let me see the part complained of, and upon examination found a tumour somewhat larger than a pigeon's egg, pulsating strongly in the course of the femoral artery, about a handbreadth below Poupart's ligament. The nature of the complaint to me appeared evident, and I gave the necessary information immediately to the surgeon of his regiment, Mr. Ivory (since dead). After church, a consultation was held by the medical officers in the garrison, when it was decided, that the tumour was a

true aneurism of the femoral artery, and that an operation was necessary. The patient was bled and put to bed. On the Thursday following, the artery was tied in the usual manner, by Mr. Ivory, with a single ligature. About twelve or fourteen days afterwards, the ligature came away. About this time I sailed for England, and concluded that my friend would do well. I may here observe, however, that I had noticed the existence of strong and general arterial action even before he complained of disease in his groin. On my return to Sydney, within a year, I learned, that soon after my departure hemorrhage had suddenly burst forth, and eventually the external iliac was tied, and the bleeding ceased. The patient suffered much. Subsequently, an aneurismal tumour of magnitude could be distinctly felt above the bifurcation of the aorta, and about the same time another appeared in one of the carotids, and the patient was given up as lost. What steps were then pursued I know not; but on my arrival at Sydney, in October following, I found the patient in perfect health, the arteries which had been dilated being considered to have resumed their natural dimensions, more particularly the carotid, which could be readily examined; no operation having been performed, and the surgeon in attendance, Mr. Gibson, being positive as to its previous dilatation."

Symptoms of Internal Aneurisms.

A preternatural enlargement of the aorta, or an aneurism, is not known to give rise to any particular or

pathognomonic symptoms by which it may be recognized during life, provided it be of so small a size as not to interfere with the functions of the neighbouring organs. Dissection after sudden death has often demonstrated the existence of aneurisms which were never suspected during life, the individuals having been presumed to have been in perfect health. When the aneurism becomes larger, and interferes with other parts, then symptoms arise indicating derangement and distress in that part or organ; but which cannot be distinguished from those dependent on idiopathic disease. Laennec has said with reference to this subject, "that there are only three important diseases in the chest, which a practitioner, well acquainted with the arts of percussion and auscultation, could not discover by pathognomonic signs; but that these signs were wanting in aneurism of the aorta, in pericarditis, and where sanguineous concretions were formed in the heart some time previous to death; and that any one of these affections might readily be mistaken for either of the other two."

When an aneurism of the arch of the aorta approaches to, or reaches the surface of the chest or back, it will then be known by the extent and force of its pulsations; and on examining the chest at a previous period by the stethoscope, the nature of the disease may be suspected from their situation, by their being synchronous with the pulse, and simple, as opposed to the double sounds arising from the motions of the heart, when in consequence of disease they are heard over the same space. In aneurism, the pulsation as well as being single has a greater degree of intensity,

and strikes more sharply on the ear than it does in any disease of the heart; although in aneurism there may be the peculiar bellows sound which often accompanies disease of the auriculo-ventricular opening. An artery, however, in a state of inflammation, has its single pulsation increased, both in force and extent, rendering the diagnosis between the two complaints doubtful, and even undistinguishable by an unpractised ear*.

The pulse rarely intermits in cases of internal aneurism, unless it be accompanied by a disease of the heart; although it may by affecting the stomach when situated behind it give rise to a sympathetic intermission, which often accompanies derangement of this organ, or anxiety of mind. An inequality of pulse in the two arms may arise from other causes, as well as from original formation. Oppression, pain, anxiety, difficulty of breathing, alteration of voice, &c. are all symptoms of other diseases, and are in them more distinctly marked. An aneurism pressing on the trachea or œsophagus has often caused a loss of voice, and so extreme a sensation of suffocation, referred to the

* The sounds occurring from the motion of the heart are two: first, the dull but distinct sound arising from the contraction of the ventricles, and which is synchronous with the pulse. This is immediately followed by the short, sharp, and cracking sound accruing from the contraction of the auricles; and this is succeeded by an interval of repose, equal to about one-fourth of the whole: the contraction of the ventricles occupying double the time of that of the auricles. A student should always begin his studies on cases of disease, and particularly on such as are likely to be examined post mortem.

larynx, as to give rise to the performance of the operation of opening it.

377 A. The arch of the aorta is irregularly swelled out in shape, and is altered in its structure on the inside. The opening from it into the aneurism is circular, and of a size capable of admitting the end of the finger: the aneurismal sac is as large as an egg, and the opening is situated below and posterior to the orifice of the left carotid. A large coagulum fills up the œsophagus at the part where the rupture took place into it. The sac is formed from the external coat of the artery, and is lined by layers of coagula. The symptoms arising from the situation of the aneurism in regard to the trachea and œsophagus, were in the first instance resembling croup, followed by difficulty of swallowing, and death from hemorrhage.

No. 373. An aneurism of the arch of the aorta, which opened into the trachea, lying completely across it. A portion of the trachea is preserved, showing the opening into it from the aneurism, about the size of a small bougie. The opening from the artery into the aneurismal sac is seen on the posterior part, immediately after the artery has given off the left carotid. All these vessels are pervious, the sac being posterior to them, the blood passing on the fore part, the back part being filled by coagulum, a portion of the sac having been removed to show it. The anterior part of the arch is diseased, but not dilated. There is no history belonging to this case, but it is probable that the symptoms were of disease of the lungs, ending in suffocation from hemorrhage. The ex-

istence of aneurism may not even have been suspected.

No. 373 A. Aneurism of the arch of the aorta, at the upper and posterior part, arising behind the arteria innominata, left carotid, and left subclavian, and lying across the trachea. It communicates with the artery by an opening of a circular form, below and posterior to the origin of the arteria innonominata. None of the vessels arising from the arch are diseased or altered, save at their very origin, where the coats of the artery are internally cartilaginous and brittle in a particular degree, and seem to have prevented the progress of the aneurism in front, which burst into the trachea about an inch above its bifurcation. There is an opening between the thyroid and cricoid cartilages, indicating that the operation for opening into the larynx had been performed, the disease having probably given rise to symptoms of suffocation before the aneurism burst.

No. 373 B. The aorta is preternaturally dilated from near its commencement, and forms a large sac posterior to the vessels arising from the arch. The internal coat of the descending portion of the artery is diseased. All the vessels are pervious. The aneurism burst into the trachea, a little more than an inch above its bifurcation. The sac in this instance is double the size of that last described.

The existence of an aneurism in the abdominal aorta may be ascertained in a much more satisfactory manner, in consequence of the yielding nature of the walls of the abdomen, which admits of the application of the stethoscope in a more direct and immediate

way. The violent pulsations of the artery may be distinctly heard, and their extent and intensity clearly distinguished. The sound will be single or simple, strong, and sonorous. These symptoms are not however alone pathognomonic of aneurism; they take place in other affections of the abdomen, which simulate the sensations communicated by an aneurism so closely, as scarcely to be distinguished from it. Violent pulsations in the epigastric region, and in the course of the ventral aorta, frequently take place without any enlargement of that vessel. When a tumour can be felt externally, the similarity to aneurism becomes more marked, and the disease is often mistaken for it, although collections of air or of worms confined in some of the sacculi of the transverse arch of the colon are known to have often simulated these appearances.

The most remarkable case of this kind I am acquainted with existed for eighteen months. The pulsations were visible through the dress. The tumour could be distinctly felt, hard and apparently incompressible, and it resembled an aneurism in every respect, save that the line of the aorta could not be more distinctly felt through it on considerable pressure being made upon the abdomen. It yielded at the end of eighteen months to a quack medicine for the cure of worms, which brought away an enormous quantity of dead tape worm, and proved the accuracy of the diagnosis. Laennec has remarked with the stethoscope, what Dr. Baillie had before noticed with the hand, *viz.* that in aneurism the pulsation of the trunk of the artery cannot be so readily distinguished in the tumour, whilst in the dis-

cases simulating aneurism, the calibre of the vessel can always be distinguished, although the force and extent of pulsation is increased.

The causes of the apparent greater or more violent pulsation in an artery in a state of inflammation, and in aneurism, as well as the greater intensity of sound emitted by the latter, have been frequently investigated, without arriving at any conclusive results. It has been supposed, that the first depends on a greater action going on in the walls of the vessel during disease than during health ; and that the latter owes its existence, not only to the greater extent of surface from which it is emitted, but to the circumstance of its taking place from a hollow space.

Symptoms and Diagnosis of External Aneurisms.

When an aneurism forms in the extremities spontaneously, and not as the result of accidental violence, it is not usually accompanied by pain, and is a soft pulsating tumour, as moveable as the nature of the parts in which it is situated will permit. It is therefore much more capable of being moved on the fore part of the thigh than in the ham. The pulsation is synchronous with the beat of the artery, and the tumour, while soft and moveable, can be diminished by pressure; more particularly, if the current of blood through the artery be suspended by compression above the tumour. The pulsation then ceases, but is restored on the compression being removed; and with the

return of the pulsation, and resumption of the size of the swelling, a peculiar thrilling feel is experienced, which gives rise to the sensation of *feeling a noise*, as well as of hearing it. It is something peculiar, which, when once felt and understood, can never be taken for any thing but the blood passing into an aneurism from the trunk of the vessel. The French term it *bruissement*, which means a sort of confused rattling noise, which is however most remarkable in false aneurisms. This resumption of size may even be augmented to a greater state of distension, at an early period, by preventing the passage of the blood through the lower part of the artery; when the tumour will of course become more tense and full; whilst a difference may be distinguished in the facility of diminishing its size by pressure, which is then accomplished with much more difficulty; the blood being obliged to retrograde into the upper part of the artery, instead of passing on in the current of the circulation. The sensation experienced by the fingers, when the case admits of these two methods of examination, is such as to leave no doubt of its nature. This kind of aneurism is slow in its growth, not perhaps exceeding the size of an egg in the course of a year, rarely that of a flattened small orange. When the aneurism has not been caused by a dilatation, but by a rupture of the inner coats of the vessel; the patient usually refers to some particular period, and generally to one of exertion, when this rupture was indicated by pain of a more or less acute nature; which either continued with a corresponding degree of lameness of the extremity, or left such a sense of uneasiness as to induce

the patient to place the hand frequently upon the part; on one of which occasions the pulsating tumour is felt, and becomes an object of so much anxiety as well as of curiosity, as not to be forgotten. The lameness of the extremity, or the incapability of motion, are distinctly marked. If the aneurism, whatever be its nature, is for example in the ham, the patient limps, from favouring the limb; but as the aneurism increases, he does so from two causes — the pressure which takes place on the nerves passing to the toes, and which gives rise to pain, not at the part affected, but in that to which the terminations of the nerves are distributed; and from the same cause giving rise to contraction of the muscles and rigidity of the tendons passing behind the joint. The leg is permanently bent, the toes and leg are extremely painful, and the foot and leg, incapable of bearing the weight of the body, become swelled and œdematous. Where the previous symptoms are present, the pain, swelling, lameness, and stiffness, only make the case, if possible, more clear; but they may equally take place from any other tumour in the part, and are only to be considered as auxiliary to the diagnosis. The tumour has hitherto been colourless, the skin unaffected and moveable, the external veins not enlarged.

As the disease increases, changes take place which render these symptoms obscure, and sometimes remove them altogether, substituting other appearances of a more doubtful character, and rendering the diagnosis difficult, if not altogether uncertain. At an indefinite period of time, coagula are deposited in concentric layers, within the aneurismal sac, and the

increase of these will naturally render the pulsation indistinct; until at last it will be readily conceived, that as the sac becomes more completely filled, it may cease altogether, or be so trifling as not to be distinguished by the hand, although it will be sensible to the stethoscope, provided the artery be pervious. If the artery has become impervious above the aneurism, it will be cured spontaneously, and the diagnosis is of little consequence; but a state will occur in which the artery is pervious, the aneurism increasing, the pulsation not distinguishable. This is fortunately not a very common occurrence, and it is even then preceded by certain circumstances, which, in connection with the history, tend to elucidate the case. The tumour has become large for its situation, and is no longer moveable, being bound down by the surrounding parts. The patient is sensible that a sudden alteration took place, which considerably augmented the bulk of the swelling, deprived it of its pulsatory feel, and rendered the whole limb more painful, more swelled, and in some cases so hard and distended as to be more than double its natural size. In these cases, the aneurismal sac has suddenly burst, allowing the extravasation of a quantity of blood into and between the surrounding parts in every direction, which usually coagulates; or it has given vent to a quantity of loose coagulated blood, which covers the artery to such a depth as to render its impulse imperceptible. The history can alone establish the diagnosis on a firm basis, the symptoms will be insufficient. A case of this kind presented itself to me some time back in the Westminster Hospital. The leg was double its natural

size, the skin greatly distended, shining, and discoloured, but not inflamed, and yielding an obscure feel of deep-seated fluctuation. The calf was evidently the part most distended, and the tumour extended into the popliteal space, but not as high as the origin of the heads of the gastrocnemius muscle. The artery could be felt above this when examined with care, but no pulsation could be distinguished in the tumour, not even by the stethoscope, so as to be in any degree satisfactory. It might be an enormous deep-seated abscess, it might be a fungoid tumour, it might be any thing else. The history obviated all difficulty. The man knew he had had a pulsating tumour, throbbing like his heart, which he had often felt at the upper part of the calf of the leg. He had suddenly felt great pain in the part, from which moment the limb began rapidly to increase in size, and he had not felt the beating swelling afterwards.

A woman was sent to the Hospital soon afterwards, with a swelling occupying the whole calf of the leg, which was four times the size of the other: the skin was stretched and shining, and there were several very largely distended veins running over the tumour. The leg was swelled and œdematous. The pain in the toes and fore part of the foot and outside of the leg was so great as to deprive her of sleep: the knee was bent. The tumour was in two places so elastic, as to give to the finger a sensation something like fluctuation, but which was not distinguishable when examined by two fingers in the usual manner: no pulsation was perceptible to the hand, and a very indistinct sensation was conveyed to the ear by the stethoscope. This case resembled the former one in its

general outline, but the history was so different as to remove all doubt. She had often examined the tumour when small, and knew that it was then hard, moveable, and not accompanied by a pulsation like her heart. I amputated the limb above the knee, and found a large irregular tumour, the walls of which were in part cartilaginous and lardaceous, the centre filled up by a pultaceous curdy matter, intermingling with the wall, which had been apparently removed at the parts where the springy feel was perceptible externally. It appeared to arise from the deep-seated fascia, and had obliterated the posterior tibial artery. The nerves either pressed upon below or stretched on the outside of the tumour, were double their natural size, as compared with a larger male limb. They were also softer and more pulpy to the feel, and whiter in their colour. On examination after death, tumours of the same kind were found on the lungs and in the liver.

In some cases, when the aneurism bursts, and a quantity of blood is suddenly extravasated, the patient becomes weak, or faints, the extremity loses its warmth, the skin becomes discoloured, and sphacelation may take place. In other instances these unfavourable symptoms have slowly disappeared, and a spontaneous cure has been effected, leaving the limb however considerably enlarged, and with the remains of a tumour, which in one instance, at the end of two and twenty years, suppurated, burst, and destroyed the patient by exhaustion.

An aneurismal sac may however become firm and hard, from the deposition of coagula, without bursting; but then the tumour will be small, the pulsatory mo-

tion to a certain extent distinguishable, and the history will remove any doubt on the subject. If the tumour remains firm and fleshy to the feel, without pulsation, and not increasing in size, it is undergoing in all probability a spontaneous cure. If about to make progress, it will become softer with its augmentation of size, and an indistinct pulsation will again be observable; unless the sudden deterioration take place from rupture of the sac, when it will be attended by the symptoms above enumerated.

A tumour, and particularly one containing a fluid, may easily be mistaken by an inexperienced person for an aneurism, when it is situated immediately above an artery; inasmuch as it will communicate the pulsatory motion of the vessel as distinctly as many aneurisms. The history will usually show that the tumour did not at first possess this motion, and only acquired it after it began to grow. An aneurism may not pulsate when it has existed for some time, or attained a great size, but it always does so at its early formation. It is generally soft in the first instance, and afterwards becomes hard, until it approaches to bursting, when it again becomes soft at the apex, or most prominent point. A tumour is, on the contrary, hard in the first instance, and generally becomes softer with time, and from the centre to the circumference. The peculiar thrilling sensation usually experienced on pressure being made on an aneurism of a circumscribed or defined shape, will be wanting; the tumour will be only elevated and depressed, without the feeling being communicated of expansion; and no compression on the vessel, above or below it, will

cause the slightest increase or diminution of it. The tumour may also, when not aneurismal, be raised from the vessel, if it lie above it, when the pulsation will diminish so much, or cease so entirely, as to leave no doubt of its nature. If the artery should run by the side or over the swelling, it may be easily traced and its natural calibre ascertained. Lastly, the tumour may be attached to moveable parts, in which case it must move with them. There are few surgeons in London, who have not seen one case at least of bronchocele, which has been mistaken for carotid aneurism, from inattention to the motions of the tumour, as dependent on those of the larynx. A gentleman, an adjutant of militia, came some few years ago to me, with an enlarged lobe of the thyroid gland, to be operated upon for carotid aneurism. It was cured by iodine. Twice have enlarged and suppurating absorbent glands, nearly in a similar situation, been brought to me for aneurism; and twice have I removed a tumour adhering to the radial artery, which was considered to be of a similar nature. The same thing happened in the groin; and it is almost unnecessary to say, that from inattention, both herniæ and aneurisms have been opened for common suppurating abscesses. I saw this mistake once made in hernia with the best effect. The surgeon punctured the tumour, which was incarcerated, hard, and painful, with a lancet (fortunately the opening was but a puncture), and was very much alarmed to find a watery, fetid fluid evacuated, followed by a little fecal matter. He closed the opening by a piece of adhesive plaister, placed a compress upon it, and the patient recovered without any further bad symptoms.

Pelletan, among other authors, gives two instances in which aneurisms of the axillary or subclavian artery were opened, and the patients died of hemorrhage in consequence. In one case the parts were carefully dissected, and the axillary artery immediately below its dilatation was in so impervious a state as not to admit the smallest probe, and looked like a ligamentous cord. At the bend of the arm it resembled an artery in appearance, but its canal was so contracted that nothing could be introduced into it. If the engraving given by Pelletan represents the disease correctly, it was a case of preternatural enlargement, with a consecutive false aneurism. Scarpa and most other authors notice similar unfortunate accidents.

Blood may be extravasated in such quantity, in consequence of a very severe contusion, in the course of an artery, as to receive and convey from it a pulsatory feel. This can however only happen when the blood remains fluid, an occurrence which sometimes takes place. I have known but two instances of this kind, both in the thigh; and the symptoms distinguishing it from aneurism were sufficiently marked, by the rapid formation and subsequent non-increase of the swelling after it attained its full size, and the indistinctness of the pulsation, except on the line of the artery, under due examination. When an artery is ruptured, or injured by a broken bone, a false or spurious diffused aneurism is the consequence, placing the limb under circumstances which will most frequently give rise to amputation, if that operation can be executed. If it be a compound fracture, the aneurism has lost its distinguishing quality, *viz.* that of a shut sac, and

is brought to the state of a wounded artery, with the disadvantage of the whole of the parts being in a state of derangement, which may render the success of any operation very doubtful.

An abscess may form from irritation, between the skin and the aneurismal sac: it will then give rise to external inflammation, pain, fluctuation, and the erosion of the skin, if not opened by the surgeon and the matter evacuated. This is a very rare occurrence, and the history of the disease will explain its nature, which is always dangerous, inasmuch as the consequence of the suppuration is usually ulceration of the sac, followed by hemorrhage.

Breschet, in the notes attached to his translation of Mr. Hodgson's Treatise on the Diseases of Arteries and Veins, has published a remarkable case of an encysted tumour, communicating with the aorta, the nature of which may admit of a doubt, but the diagnosis must have been at an early period exceedingly difficult, if not impossible. A child, ten years and a half old, of a nervous temperament, but enjoying good health, suffered an attack of fever, from which she recovered. During her convalescence, three abscesses formed successively in the neck, the back, and on the posterior part of the sacrum. The parents then perceived a tumour on the anterior superior part of the thorax, extending to the left side of the neck. A student in medicine, who attended the child, examined the swelling; and finding a fluctuation, without heat, or alteration of the colour of the skin, or pulsation, and not diminishing on pressure, nor giving pain, &c. presumed it was of the same nature as the other three;

and having opened it, a jet of blood was thrown out, and continued to be discharged until the tumour was emptied. A slightly irritating fluid was then injected into the sac, and allowed to remain for some minutes, when it was evacuated, and a compress and bandage placed on the part, for the purpose of promoting adhesion of the sides of the sac. During the night, the bandages, &c. were wetted through by blood, which then issued from the opening; and on taking them off next morning, blood flowed by drops from the wound, giving rise to the belief that it had done so during the whole of the night; and the tumour was evidently distended by a fluid. There was as yet no pulsation. The day after, some slight pulsations were perceptible, and the aneurismal nature of the swelling was suspected. Urgent general symptoms rapidly came on, and two days afterwards she died. On examining the body, an injection was first pushed from the descending aorta upwards, which evidently distended the tumour; the dissection of which showed that it was formed as it were of two parts, one exterior to the sternum, the other within it, communicating by an opening in the bone, which was much altered in its structure, and crumbled away on being touched. At the bottom of the internal cavity, the anterior surface of the aorta was seen, the tumour lying upon it. It was not in the least dilated, but had a small hole in it, on the anterior part of the arch near the arteria innominata, one line and a half long, and one in width.

Breschet remarks, that in sanguineous tumours communicating with the cavity of an artery by a very

small opening, pulsations are not discoverable in the first instance, whilst the swelling is deeply seated; and that at a later period, the movement of the parts is not a distinct pulsation, but a sort of vibration or fluttering.

If there was really an aneurismal tumour in the first instance, rather than an erosion of the artery from extension of disease to it from the cellular structure beneath the sternum, I conceive the opening from the artery into the cellular structure must have been exceedingly small.

Abscesses do sometimes form in these parts, and obtaining an impulse from the vicinity of the aorta, simulate the appearance of an aneurism as soon as the fluctuation becomes distinguishable. The discharge of the matter, and the subsequent cure of the patient, proves their nature. Warner has related the history of a case of this kind, occurring from injury of the sternum, deserving of attention. It is as follows:

"The broken parts of the bone were removed some distance from each other. The intermediate space was occupied by a tumour of a considerable size; the integuments were of their natural complexion. The swelling had as regular a contraction and dilatation as the heart itself, or the aorta, could be supposed to have. Upon pressure, the tumour receded; upon a removal of the pressure, the tumour immediately resumed its former size: all these are allowed to be distinguishing signs of a recent true aneurism. The situation and symptoms of this swelling were judged sufficient reasons for considering the nature of the dis-

ease as uncertain: on which account, it was left to take its own course. The event was, the tumour burst in about three weeks after his admission, discharged a considerable quantity of matter, and the patient did well by very superficial applications."

If an artery should have taken an unusual course, and given rise to a pulsating tumour where one is not usually expected, it may under such circumstances render the case for a moment doubtful. The best instance of this kind is recorded by Pelletan, in a man whose anterior tibial artery, instead of lying concealed until it reached the instep, became superficial at the middle of the leg, penetrating between the tibialis anticus and the extensor communis muscles, and was only covered by the fascia and integuments. An effusion of blood at the lower and anterior part of the leg, which took place from an injury, received from this artery a pulsatory motion, which rendered its nature doubtful, until the other leg was examined, when the same irregularity was found to exist. A large artery implicated in or surrounded by a tumour, is usually obliterated by its pressure.

Lumbar or psoas abscesses may, under certain circumstances, be mistaken for aneurisms, which are of slow formation, and unattended by pain. The patient shows a small swelling immediately over the femoral artery in the groin, soft, moveable, fluctuating, having a strong pulsatory motion, and unaccompanied by pain. The tumour diminishes on pressure even in the erect position, and rapidly returns as it would do in aneurism. The pulsation is manifest, but after the swelling has been diminished by pressure, its sudden

resumption of size in the erect position is not accompanied by the peculiar aneurismal pulsatory thrill felt in a preternatural enlargement, or aneurism. When the patient is placed in the recumbent position, and the tumour is diminished, or altogether removed by pressure, which may be done; it does not return if the case be one of chronic or psoas abscess on the removal of the pressure, as it would and must do in a case of aneurism, if it were blood that caused the swelling. The course of the artery may now be examined more readily, when the swelling has disappeared, or nearly so, by the retrocession of the fluid within the cavity of the abdomen, and the nature of the case will be evident. In most cases of abscess, the appearance of the swelling will have been preceded by pains in the back and loins of some standing, and which continue, with weakness of one or both extremities; but these symptoms are not always observable. In the only case I have seen of chronic abscess simulating aneurism, so as to admit of any reasonable error being committed, they were totally wanting; so that the disease could only be distinguished by the means above enumerated.

On the Medical Treatment of Aneurism.

The medical treatment of aneurism is almost entirely confined in the present day to those which are internal; or to external ones in which an aneurismal diathesis is presumed to prevail, rendering the cure of one tumour

by operation useless, when others of more importance are known to exist beyond the reach of art.

The presence of an aneurismal diathesis cannot be disputed when several aneurisms are found to form about the same period of time. It is not, however, when they are confined to the extremities alone, that this state should be supposed to be present, but when they exist in different parts of the body; when external and internal ones are combined in the same individual. These cannot be supposed to depend on the force of the circulation alone, but on some peculiar state of the vessels themselves, predisposing to the disease, and the nature of which, if it were discovered, might admit of a remedy. Circumstances may give rise to the formation of an aneurism in each leg or thigh of an individual, without the rest of the system being so implicated as to occasion others. I had some years ago a man under my care for other complaints, who had been operated upon by Sir E. Home twenty years before for aneurism in each ham, from which he recovered, and never had a symptom of that disease afterwards. It is only when external aneurisms are complicated with disease of the organs within the chest or abdomen, or are attended by anomalous symptoms of derangement in those parts, or are numerous, that this diathesis can be fairly said to exist; and that internal or palliative treatment is to be preferred to the external or curative process by operation.

The internal treatment is very limited in its nature, and has not undergone any improvement since the time of its inventors, Valsalva and Albertini. Val-

salva has left no record of his practice, and what we know of it is to be found in the memoir of Albertini and the works of Morgagni. It has been practised with various success by most physicians, and noticed by all authors treating on this subject since their time; and although the accounts of many successful cases are to be found, and some of them sufficiently perspicuous and remarkable, the practice has not maintained its ground as a curative process, but has on the contrary fallen almost into disuse from its severity. It consists, First, In placing the patient in a recumbent position, and keeping him on as small a quantity of the least nutritive food and drink as is consistent with the support of life. Secondly, In abstracting blood from day to day, first in large quantities and afterwards in smaller ones, until the force of the circulation, and the circulating medium itself, are reduced to the lowest possible degree consistent with the safety of the patient. Thirdly, The administration of such remedies as will assist in reducing the action of the heart and arteries; whilst they act at the same time on their intimate structures, inducing in them a more rigid contraction and a healthier action: digitalis, acids, and the preparations of lead, are those most relied upon for these purposes. Fourthly, The application of cold externally, by means of ice, snow, or evaporating liquids or preparations, and the use of bandages where their application is admissible.

The first means of cure will readily be submitted to by most persons aware of their danger. There is nothing repugnant to the feelings of the patient, or very contrary to his ideas, in absolute rest and rigid abstinence

approaching to starvation. By gradually reducing the quantity and quality of the food and drink, it may be brought down to four ounces of solids and eight ounces of fluids without difficulty, and in some cases even below that quantity for weeks together. But when this is combined with the daily abstraction of blood, both the patient and his friends take alarm, and the necessary discipline is no longer enforced. To be efficient, however, it must be rigidly carried into effect. Blood should be drawn freely in the first instance, and from a large orifice, until the patient faints, a point which is only attained in some persons, when in the recumbent position, after the abstraction of a considerable quantity. This may be done daily, or every other day, for three or four times, from twenty to thirty ounces being taken away each time; but after that, and in delicate persons before it, bleeding to syncope in the recumbent position should be avoided, inasmuch as it is possible that the patient may never recover from it. From eight to ten ounces should then be drawn at a time, and at a later period from four to six only, and that from a small orifice, or with a ligature so loosely applied that the blood may merely trickle down the arm, or flowing, as the French term it, "en nappe."

Starvation, combined with frequent abstractions of blood, soon renders the patient exceedingly thin, the countenance pale, and reduces the strength to such a degree that he can scarcely move. The blood loses its fine moreen colour, and becomes pale and watery; the quantity of serum greatly preponderates, the crassamentum becomes soft and small in quantity, and the attempt at removing one disease is likely to be

followed, if the patient lives long enough, by the formation of others, dependent on the abuse of the curative method employed. The constitution of each person must be studied, and his powers of resistance well calculated, so that they may not be reduced below that level from which they cannot recover. As this point is approached, the state of the aneurism should be most carefully inquired into, and as far as possible ascertained. If no improvement has taken place, it would be an error to persist in the treatment, which would not benefit one complaint, whilst it would certainly give rise to others equally fatal. But if the aneurism has evidently diminished in size, and its pulsations have become more, if not entirely indistinct, a certain risk may be run to attain the great object in view. As soon as a well-marked amendment has taken place, the severity of treatment should be mitigated, particularly as regards the loss of blood, and gradually abandoned in every other point; although the recumbent position and abstinence should be enjoined until every symptom of disease has been removed.

Digitalis is a remedy which may be given with advantage in the first instance, but it is one which not only lowers the action of the heart in a remarkable manner, but which will also sometimes put a stop to it altogether. I have known it do this when given in large and repeated doses for the cure of tetanus, and I am therefore not disposed to recommend its use after the action and power of the heart have been considerably diminished.

The mineral acids and the superacetate of lead have

been recommended, solely I believe because they have been known to do good in acute and chronic hemorrhages. The mineral acids I have not seen exert any very powerful influence in these cases; but the superacetate of lead I have often found a most valuable remedy in both, when combined with opium; acting apparently on the vessels that had lost their tone rather than on the blood; perhaps on both. I therefore recommend it, as a remedy which may possess the power of removing chronic inflammation of the coats of arteries, and of inducing a return to a state of health. In the proportion of a grain to a quarter and to half a grain of opium, three or four times a day, I have never seen it do any thing but good, and I have given it in much larger doses without any bad effect.

The external means, such as the application of cold by ice, snow, &c. have been known to be serviceable, although they are perhaps more generally abandoned than the internal treatment. The application of pounded ice inclosed in a bladder often gives great pain, from its weight as well as coldness; and when applied to the trunk, often becomes from both quite insufferable; whilst it will in all probability give rise to affections within the chest or abdomen, as formidable as the disease it is intended to remove. I am not inclined to place much reliance on its use in external aneurism: it is proper nevertheless to state, that instances are recorded by Larrey, Ribes, and others, in which it seems when steadily persevered in to have effected a cure. It is said also, that under a continued use of it mortification of the part has supervened.

On the Collateral Circulation.

By the term collateral circulation, in cases of aneurism or of wounded arteries, surgeons understand, the means whereby blood is sent to the extreme parts of the body or to a member, when the supply through the principal trunk or vessel is cut off, either by disease, injury, or the application of a ligature. Nature in our formation seems to have been aware that obstacles would arise, preventing the free circulation of the blood in every part of the body; and has provided against them by establishing circuitous communications, through which, not only is a part supplied by arteries arising from different trunks; but arteries arising from distant parts of the same trunk are made to anastomose with each other, sometimes directly, sometimes even through the intervention of one or even more sets of vessels. The study of these anastomoses offers one of the most interesting pursuits in anatomy and physiology; but which was little attended to until nearly the present time. There is no point in surgery on which a greater discrepancy of opinion will be found on inquiry to exist between the ancient and modern surgeons, than on the capability of the collateral circulation to maintain the life of the lower extremity after the supply through the principal trunk has been cut off. The ancients, and indeed many of those who existed until within the last thirty years, believed this to be nearly impossible; or when it did take place to have occurred from some accidental play of nature, rather than from any regular order of proceeding. The surgeons of the present day have for the most part

adopted the opposite opinion, and believe that the collateral circulation is sufficient in every case to support the life of the extremity; and suppose, when it does not do so, that it arises from some accidental defect, rather than from any regular incapability on the part of nature. As she has always been the same, there must be some reason for this difference of opinion, supposed to be founded upon and supported by facts on both sides, which require explanation.

The older surgeons, who operated on arteries, were by no means well acquainted with their situation and connections; or if they possessed this knowledge, they do not seem to have been aware that success did not depend on the operation being duly performed according to their intentions, but on its being done with the least possible inconvenience or injury to the surrounding parts. It is not enough that a ligature be properly placed on an aneurismal artery; it is essential that it be done without injury to the accompanying veins or nerves, that no compression be afterwards made on the limb, and that the operation be performed in sound parts, not prone to inflammation and suppuration. No one however can read the history given of their operations without perceiving, that they attended but little or not at all to these points. In many instances, the operator fairly admits that he does not know whether artery, vein, and nerve, were included in the same ligature or not. In others it is acknowledged, that one or both were so included, and often even with a due proportion of skin and of surrounding parts. The ligature was used with a large needle; and was in fact composed of so many threads as to be

a cumbrous tape, or cord, which could not fail to irritate the vein to inflammation, even if it luckily escaped the needle. In the first case in which it was proposed to place a ligature on the subclavian artery, immediately below the clavicle, it was decided by a majority of consultants, that the pectoral muscle should not be cut, but that a needle should be struck through it, with the hope of catching the artery, but which was not accomplished. The situation of the axillary vein seems to have been totally overlooked, or at all events to have been considered of no importance. The danger to be apprehended from wounding or tying up the vein as well as the artery, is nowhere duly insisted upon; and the neglect of it was, I have no doubt, the principal cause of gangrene taking place so frequently as it appears to have done. If the vein escaped the first ligature, it was little likely to do so with the other three or four, which were sometimes applied. I have had many opportunities of seeing the vein and artery of a limb divided by a wound, or included in a ligature, but I have rarely seen one in which mortification did not ensue; and I am disposed to consider it as a general rule, liable to an occasional exception, that where the femoral artery and vein are divided, or included in a ligature, the limb will be lost by gangrene.

Lest I should be accused of exaggeration, I give the following passage from Deschamp's Observations et Reflexions sur la ligature des artères, &c. &c. seconde edition, 1797, page 99, paragraph 175. "In the subject of the 9th observation, I included the artery and vein in the noose of the ligature. Doubts have been

raised as to the inconveniences which might arise from obliterating the vein; but the experience of all times ought to relieve us from any imaginary fear of this kind. It is not the same with the veins, even the principal ones, as with the arteries. They are so greatly multiplied, and their diameter is so great, compared with that of the arteries, that the return of the blood suffers no delay; and I do not believe than in such a circumstance a surgeon ever wishes to separate the vein from the artery."

The arteries of the lower extremity may be just sufficient to supply the extreme parts with blood; but if the capillary circulation be embarrassed by congestion in the veins, from the obstruction of the principal venous trunk, the already labouring arteries become oppressed and unequal to their office. But these are not all the difficulties which the sanguiferous vessels had to encounter. The operation was performed on unsound parts, the aneurismal sac was in general laid open, and after being emptied of its contents, was crammed full of lint, bound down by compress and bandage to prevent hemorrhage. These bandages could not fail to compress not only the superficial veins, but the collateral arteries also; and in this manner the very means by which the life of the limb was to be maintained were interrupted. In all cases in which the circulation is not fully re-established at once, there is a period of doubt, in which a sort of contest is carried on by nature for the life of the limb, in which she is sometimes successful, often the reverse. It is by setting up an action in the vessels, something of an inflammatory nature. But how is this

likely to be effected in the neighbourhood of a great wound, such as has been described, and tending from its unhealthy character to suppuration and sloughing? It certainly must be an obstacle of no trivial nature.

Compare with the preceding sketch the operative process of a modern surgeon.

The parts in which the disease is situated are rarely touched, the operation being often done at a considerable distance, and in sound parts, admitting nearly of union by the first intention. A bandage is never applied to the limb. The veins and nerves accompanying the artery are most scrupulously avoided. The artery is tied with a single small ligature, in the application of which, it is scarcely separated from its natural connections.

With such a difference of practice, it cannot for a moment be a matter of surprise, that there should be a difference of result; that surgeons of the present day should place an almost unlimited confidence in the capability of the collateral branches to carry on the circulation when the main trunk of an extremity has been cut off; and that the occurrence of gangrene after such an operation should rather be considered as an accidental exception to the general rule, than the rule itself.

The great success which has attended the practice of the present day in the operations for aneurism, has however led to an overweening confidence in the powers of the collateral circulation, which it assuredly does not under all circumstances possess. The older surgeons did not perceive in their full extent

the disadvantages under which their operative processes laboured; modern ones have overlooked, in the consideration of this subject, the various advantages they on the contrary enjoy in the cases of aneurism on which they have operated. They adopted hastily, in consequence, the theory of the operation for aneurism in the treatment of wounded arteries, not only with relation to collateral circulation, but to other more important points in which it was not admissible. The result of this practice has been, a want of success nearly as marked in cases of wounded arteries as it was the reverse in aneurism. The causes of this failure also require explanation.

The collateral circulation is more perfect, more active in young persons, during the increase or growth of the body, than it is either at maturity, or in the decline of life. Every action is carried on in consequence with more facility and certainty, and a greater dependence can be placed both on the powers of the part and of the constitution, than at any other period. Observation has proved the correctness of this statement; and in cases of aneurism, or of wounded arteries, in which the principal or only trunk has been cut off, the collateral branches have been found to be more efficient between the ages of puberty and of the first period of manhood, than at any subsequent time of life. In old age there are many reasons why the powers of the smaller arteries should be comparatively defective, which it is not necessary to advert to, as the fact is admitted. The important point is not however alone referable to the time of life in which the operation is performed, but to the nature of the disease or

injury; and the period of time after the reception of one, or the commencement of the other, that the operation is done, and the call is made on the collateral circulation to maintain the life of the part.

When an operation has been performed for aneurism successfully, and the patient has died, the dissection has shown various arteries enlarged, both above and below the part where the trunk was obliterated by the ligature; and not only an enlargement of arteries, which from their regularity have received names, but others have been developed, not known usually to exist, or not of a size to be conveniently traced. These through their frequent anastomoses bring the blood at last into several larger trunks, by which it is again conveyed to the original vessel below all and every obstruction which may have taken place; for an operation is only successful when the obliteration of the sac accompanies that of the artery where the ligature is applied. This dissection proves two points: 1. That arteries known to exist have become very much enlarged, when compared with those of the opposite side; and that others, not discoverable in the sound limb, have been developed in a similar manner; and both together to such an extent, as will nearly if not quite compensate by a circuitous route for the loss of the direct supply. The principal object of inquiry now is, do these vessels always exist, or at what period of time do they begin to enlarge, so as to enable them to carry on the circulation, in the manner in which it is presumed to be done? for few will assert, that the enlargement of these particular collateral vessels was an accidental play of nature, and existed previously to

the commencement of the disease or injury for which the operation was performed. On this point, the theory of the operation for aneurism and its applicability to wounded arteries appear to hinge; and what is of more importance, on which the practice resulting from it depends. It is therefore worthy of serious consideration on several grounds.

In the natural state of parts, nature has been careful that no individual spot shall be supplied with life by one blood vessel alone. This is beautifully exemplified in the extremity of the finger; two constant arteries run, one on each side of the inner part of it, into the very extremity, where they communicate largely. If both these vessels be cut across, at the root of the finger, smaller ones would yet communicate with each along the back and sides of it, until the blood at last found its way into the anastomosing branches at the termination of the two principal trunks which have been divided, and would cause a reflux hemorrhage through them. The capillary arteries of the finger have, in the first instance, propelled their blood into the veins; receiving no further supply, they remain empty, or (through their emptiness) draw upon their surrounding communications, which again exert, or continue this influence to more distant parts, until blood begins to flow and is propelled towards them, from a part which receives a more direct supply. In the hand, which is exposed to so many injuries, a further provision is made: two large arteries are sent to it along the inside of the arm, and these anastomose, not by capillary vessels, but by direct communicating trunks or branches in the palm of the hand, so con-

stant and so large as to be regularly sought for by the anatomist. Lest these should be destroyed, vessels have been given off above the wrist, before and behind, descending to the hand, and communicating upwards with the arm. If the trunk be cut off above the elbow, the articulating arteries above communicate with the recurrent branches from below the joint; these again with the wrist; these again with the hand; and so on until the circulation is sufficiently established to maintain the life of the whole. This sketch will apply as well to the foot as to the hand, save that it is less extensively supplied, and its principal trunk is more distant. It shows that there are two distinct kinds of collateral circulation: one by direct large communicating vessels; the other through the indirect medium of the capillary arteries, inosculating with each other. Where the direct communicating vessels exist, little or no subsequent change takes place in them. It is otherwise with the indirect capillary vessels, and must necessarily be so; a change must take place in them, or the integrity of the limb could not be preserved. When the radial or ulnar artery is divided in the hand, the blood will not only flow readily from each of the divided extremities, but equally red and arterial from both; the communication being through direct arterial branches from one vessel to the other. It will also be red and arterial if the division take place at the wrist; but let the brachial artery be divided in the middle of the arm, or the femoral in the middle of the thigh, and the colour of the blood issuing from the lower end of the artery, if any issues at all, will be black, it will be venous blood. It is so, because it has

been obtained from the capillary arteries; and it would appear that the blood changes its scarlet colour to black in its passage through them as well as in the capillary veins. Moreover, as there is a direct communication between the capillary arteries and veins, and as the capillary arteries evidently communicate with each other, blood is drawn into them from the veins. Now, as the valves in the veins do not when they are to be found, close up the passage so as to prevent a reflux in them, there is no reason to believe that they act otherwise when they may exist, but are not to be found. It appears to me, therefore, sufficiently plain, that the collateral circulation is carried on in the first instance by blood drawn in part from the veins as well as the arteries. The quality of the blood is defective as well as the quantity. It is necessary that a change should take place to restore the circulation to its natural state; and dissection proves that it does so in the formation or gradual development of new arteries. If a limb be injected and dissected most carefully, four or five days after a ligature has been placed high up on the principal trunk, the capillary vessels will be seen to be well injected; but few or none will be found large enough to admit of the inosculation being traced throughout. If another limb be injected and dissected, forty days after the ligature had been applied (and these experiments have been made on animals, and opportunities have occurred of making similar dissections on man) a difference will be distinctly observed between the two preparations. In the latter, the capillaries will not appear to be so fully injected, but several larger and

more tortuous vessels will be found in situations where they were not expected to exist; and the anastomoses of these one with another, and generally by arches, may be traced to their communication with the principal trunk, both above and below the obliterated parts. Let an incision now be made in the nearest pervious portion of the lower part of the artery, and red arterial blood will issue from it. The communication has become direct by communicating branches, and the capillaries have returned to their accustomed duties. After the lapse of years, these communicating branches will again appear to have diminished their numbers, one or more will have become predominant, forming large direct canals of communication, and the smaller will have shrunk up, or be no longer discernible. The limb has in fact returned to its natural state.

In June last, I happened to be at Windsor on a visit, and was called to a young gentleman, the upper part of whose right femoral artery had been cut by a scythe. A tourniquet had been applied after he had lost a great quantity of blood. On examining and dilating the wound, the tourniquet being on the limb, black blood flowed freely from it; on unscrewing the tourniquet by degrees arterial blood showed itself, and the artery was readily included in a ligature, when the tourniquet was removed. Venous or black blood now flowed in greater abundance than before, and evidently from a large vessel. This I restrained by pressure with the thumb of my left hand, whilst I laid bare the lower part of the artery with the scalpel. The slit or cut in the side of the artery was an inch in length, and was clearly exposed, and the black blood

was seen to flow from it. A ligature passed around the vessel, immediately suppressed the hemorrhage. The artery was not divided, although there was an inch between the ligatures. This took place at Eton, in the presence of Dr. Fergusson, Sir J. Chapman, Mr. G. Chapman, and Mr. Hammond. The young gentleman perfectly recovered. It appears to me, that both a physiological and surgical fact are here brought under observation, which have hitherto escaped the consideration they deserved. The surgical one cannot be too strongly impressed on the minds of students. It is that the reflux blood from the lower end of a great artery, after its division, will be of the colour of venous blood; that it will flow also like blood from a vein. After the lapse of several days, it will assume more and more the character of arterial blood, but will not obtain the same degree of impulse which is so remarkable when it proceeds from the upper extremity of the artery.

During the first twenty-four hours after the division of an artery such as the femoral, or the application of a ligature, the temperature of the limb is always diminished; after that period, and as the action of increase takes place, the temperature is usually from three to five degrees higher than in the opposite healthy limb. At the end of from eighteen to twenty-eight days, in a successful case, the temperature is found to be only equal to that of the opposite limb. The increase of action is no longer required, and the capillaries have returned to their usual duties.

It is asserted by some sanguine supporters of the all-powerful influence of the collateral circulation,

that it is sufficient at all times, and under all natural circumstances, to maintain the life of the extremity. This opinion is overturned, firstly, by the fact, that mortification is known frequently to occur. There are many cases of it on record in the older authors, and others are, and will be recorded, in which no objection can be taken to the operative process or the after-treatment. Secondly, it is admitted that nature never does any thing unnecessarily. Now if those vessels, which are called collateral, are found on examination to be enlarged or developed in so great a degree as to form a marked feature in the dissection of the part, whilst those of the opposite side show no such enlargement, it appears that they must have been so developed for a particular purpose, *viz.* the carrying on of the circulation after it has been obstructed; and it must be admitted (if nature never does any thing unnecessarily) that this enlargement is necessary for the accomplishment of this object; and that it did not exist previously to the disease or accident, but took place as a consequence. It is not worth disputing whether the vessels actually existed previously to their enlargement, or whether new ones have not also been created, inasmuch as it is difficult of proof; and although it may be an object of curiosity, it is not one of the slightest importance in our inquiry.

The fact of the development of the vessels having taken place after the commencement of the disease or the reception of the injury being established, the question of time is now to be considered. Does it commence with the disease, take place during its progress, or only after the operation? I am of opi-

nion, that the collateral branches begin to enlarge shortly after the commencement of the disease, as a part of the curative process which nature endeavours to set up in most instances; the essential points of which are, in an extremity, 1st, the obliteration of the artery above and below the tumour; 2d, the coagulation of the blood within it; 3d, the enlargement of the collateral branches above and below it.

When a limb is lost through mortification, as the consequence of a division or obstruction of the principal artery, it usually takes place after the infliction of a sudden injury, in consequence of the collateral branches not having had time to enlarge.

If the femoral artery be punctured near the groin, and a diffused aneurism form in a few days, extending up to Poupart's ligament; can the operation of placing a ligature on the external iliac be performed on the same principle, or with the same hope of success, as if the case had been one of true aneurism of several weeks or months formation? The answer is in the negative. The present theory of aneurism is not applicable to the case. The surgeon who placed a ligature on the external iliac, would probably lose his patient from mortification, because the collateral branches would not yet have had time to enlarge.

When an aneurismal limb has been injected, on which an operation has not been performed; the collateral vessels have all been found larger and more fully shown than on the opposite side, although not to the same extent as in cases of a similar nature in which the operation had been done.

It is necessary that this enlargement of the

collateral branches should take place, because in many cases the artery beyond or below the tumour is obliterated long before any operation is performed. The main supply of blood is already cut off from the extremity, and the operation adds very little to the derangement of the circulation which has already taken place below the tumour.

These facts appear to me to be conclusive: they show that the collateral circulation is not the same, is not in the same stage of preparation, in a limb suffering from a divided artery, as in one in which an aneurism has for some time existed; and they also show why mortification is more common after wounded arteries than after operations for aneurism.

Three practical deductions may be made from these facts.

1. That the theory of the operation of aneurism, as dependent on the collateral circulation, cannot be applied with safety to aneurisms dependent on wounded arteries.

2. That it is inapplicable to wounded arteries.

3. That the length of time a spontaneous aneurism has existed is of consequence, as connected with the collateral circulation; although an aneurism should never be allowed to attain that size which may render it injurious to the surrounding parts.

I shall remark in conclusion—

1. That the collateral vessels are at all times and under all natural circumstances capable of carrying on the circulation in the upper extremity, whatever disease or injury may affect the principal trunk. Whenever the reverse takes place, it is an exception to the general rule.

2. That after operations for aneurism in the lower extremity, the collateral branches are almost always equal to carry on the circulation through the limb.

3. That when the principal artery of the lower extremity is suddenly divided, without any previous disease having existed, mortification is not an uncommon occurrence, and is more likely to take place in old than in young persons.

4. That when under such circumstances the principal vein is also divided, mortification seldom fails to be the consequence.

On the Surgical Treatment of Aneurism.

The surgical treatment of aneurism has been attempted in several ways: principally by general compression on the limb; by immediate or direct compression on the artery; by the application of one or more ligatures. By general compression is understood, the application of bandages to the whole limb, and more particularly by pressure made on the tumour and on the artery above it, by the proper use of compresses. Guattani first recommended this method; but it was so little successful in his hands, and so much less so in that of his successors, that it has been abandoned altogether, since the modern improvements in the operation for aneurism have rendered it less dangerous and more certain. Direct or immediate compression on the artery is effected in two ways: 1. By pressure made on the artery through the integuments by means of a compress, or by a pad affixed to a spring, which con-

fines the pressure to the spot immediately over the artery, without impeding the collateral circulation. 2. By laying bare the artery, and compressing it with a spring or forceps, or by the application of a temporary ligature, to be removed at the expiration of a certain number of hours.

The application of pressure by means of a spring pad has been often tried, and has sometimes although very rarely succeeded. The process is long, the pain great, and there is danger of the part sloughing. The pain is however so great that few persons can be persuaded to submit to it; and those surgeons who have tried it once, will not again put it in competition with the operation. Mr. White, one of my colleagues at the Westminster Hospital, and who is an excellent surgeon and an able operator, tried it in a case of popliteal aneurism in a woman, by means of a newly invented spring, supposed to possess peculiar advantages. The woman bore the pain heroically for five days, but the parts compressed sloughed deeply. The cure was completed; but the pain, danger, and risk incurred, were infinitely greater than any which could have been sustained from the usual operation. I watched the progress of the case with great attention, and will not be easily induced to use that or any other instrument for such a purpose.

The application of a solid instrument to the artery for the purpose of compressing it for a certain time until inflammation shall have taken place; or that of a temporary ligature to cut through the inner coats of the vessel, and then to excite inflammation; have been tried in different ways by a variety of sur-

geons. The forceps, pincers, or presse-arteres, are the oldest inventions, and the worst of the two, but both have been found inferior to the single small round permanent ligature, and have been consequently abandoned.

The operation by which one or more ligatures are applied to the artery is the only remaining method for consideration, and it is of very ancient date and origin. Ætius, who lived thirteen hundred years ago, recommended for the cure of brachial aneurisms, that the artery should be exposed near the arm pit, and that two ligatures should be applied to it a little distance from each other, when the artery was to be divided between them. If he had stopped here he would have performed the modern operation for aneurism, and have left nothing for posterity to discover. He directed, however, that after this had been done, the sac should be laid open, and completely emptied, and the artery sought for, and raised with a blunt hook. A ligature was then to be applied above and below the opening in it, and the vessel was afterwards to be divided. In doing this latter part he performed the operation which ought now to be done when a similar accident occurs in bleeding, and when any operation is required. It is very remarkable, that he should have combined in one the two methods of proceeding of modern times; either of which would have been sufficient alone, if applied to cases proper for their adoption. The first in any kind of true or spontaneous aneurism. The second in any case of aneurism following a wound of an artery, as in bleeding.

Paulus, a century later, recommended the cutting

out of the tumour and its contents after opening it, having previously applied a ligature above and below it. And in this state the surgery of aneurism remained until after the middle of the sixteenth century, when Guillemeau advised an incision to be made from above the top to the bottom of the tumour. The artery was to be then sought for, and a ligature was to be placed around it above the aneurismal sac, which was to be opened, emptied of its contents, filled with lint and various surgical applications, and left to heal by the usual processes of suppuration and cicatrization.

Peter Kiesler, in 1644, performed the operation in Italy for popliteal aneurism, with this difference; that he first opened the sac, and then introducing a probe into the upper end of the artery, raised it, and passed the ligature underneath, so as to place it as high as possible, in order to avoid a dilated or diseased part of the artery: the cavity was then filled with lint dipped in vinegar and water, and a proper bandage applied over all. Of four operations, performed in this manner, according to the relation of Testa, of Ferrara, in a letter to Cotunni of Naples, three were successful.

In 1646, M. A. Severinus, aided by J. Trullus, performed the first operation known to have been done on a femoral aneurism, by opening the tumour, evacuating the contents, and placing a ligature above and another below the opening in the artery, which had been made by a musket ball.

Botentuit, forty-two years afterwards, performed a similar operation at the Hotel Dieu with success, in an aneurism from a sword wound.

Birchall, in 1757, performed the first recorded ope-

ration in England on the femoral artery, at the Manchester Infirmary.

Pelletan says, 1780, that he was then the first who had tied the popliteal artery in France for aneurism.

Anel published, in 1713, at Turin, in his work on fistula lachrymalis, the following account of an operation for brachial aneurism, which he had done at Rome in 1710.

Father Bernardin de Bolino perceived a tumour at the bend of the arm a short time after having been bled; fifteen days afterwards, the wound made by the bleeding reopened, giving rise to a hemorrhage, which was arrested by astringents, aided by compresses. The wound in the integuments closed, but again opened; and when Anel was consulted, the tumour was much enlarged, and the sac laid bare by the ulceration of the integuments. The operation was performed the 30th of January, 1710. Having applied the tourniquet, he made a longitudinal incision over and in the direction of the artery above the tumour, but without interfering with it. Having laid bare the artery, he carefully separated it from the neighbouring parts, particularly the nerve, and placed a ligature upon it immediately above the tumour. The tourniquet being loosened, blood appeared, but another ligature placed above the first put a stop to it. A ligature was not applied below the aneurism, neither was the sac opened. The first ligature came away on the eighteenth day; the second on the twenty-eighth. The wound closed quickly, the tumour rapidly diminished, and ultimately disappeared.

Desault tied the popliteal artery, at the Hôpital de

la Charité in Paris, after the method of Anel just mentioned. The ligature was placed immediately above the tumour, which however burst, and the patient died some months afterwards in consequence of suppuration, &c. which were followed by caries of the tibia. Deschamps, page 39, paragraph 65.

Upon the subject of this operation there is considerable obscurity; the case is always referred to by French writers, but does not appear anywhere clearly or correctly stated. Deschamps, who was surgeon of the Charité, notices it twice: the first remark is given above, the second is in paragraph 114, page 69, of the same work. It is worthy of remark, that mentioning an operation supposed to have been similar, which had been done by M. Guerin of Bordeaux, he says, that if the artery was tied immediately above the sac, he did not perform the operation of Hunter but of Anel, being the same operation as that which was done by Desault at the Charité, thus early distinguishing between them.

Boyer says, in his Traité des Maladies Chirurgicales, page 143, tome seconde, 1818, "In June, 1785, Desault tied the artery immediately above the tumour, with the intention of preserving the greatest possible number of communicating branches. The size of the tumour diminished at first, but it burst on the eighteenth day, discharging pus and blood; the opening remained fistulous, and the patient died eight months afterwards of a caries of the tibia.

Desault performed the operation a second time, but not after the method of Anel, or that which he had adopted in the first case, but "exactement" after

the method of Hunter, which he had subsequently become acquainted with.

Boyer further remarks, that Mr. Hunter's operation differs sufficiently from that of Anel and Desault, that one might with reason give to it the appellation of the method of Hunter, rather than of Anel or Desault, and he nowhere calls it by any other name; indeed the surgeons of the time of Desault appear to have considered his operation only as an experiment and a failure. Bichat, in his edition of Desault's works, *viz.* the third, 1813, gives no particulars, and only mentions the case, although it is referred to by other authors as being in the second volume, page 568; and in his Eloge de Desault, published at the beginning of the same edition, he does not claim any merit for him on this point; whilst he does not fail to do so for the idea of tying the artery below the tumour; which he says, like the method of Hunter, will perhaps abridge the sufferings of the patient during the operation, and, like it, render the consequences less fatal.

Pelletan, who published his Clinique Chirurgicale in 1810, gives a precis of the history of the operation for aneurism; and of the method of Hunter, he says, "The operation of Hunter was not new to any of us. M. Sabatier, now my colleague, and always my master, had treated a femoral aneurism fifteen years before by a methodical compression of this artery, which compression was equal without doubt to the ligature, and the patient saved his life and his limb. At the same time that the operation of Hunter became known to us, M. Desault, then principal surgeon of the Charité, had occasion to perform the same operation, that is,

he cut down on a wounded femoral artery, which had become aneurismal, and placed a ligature above and below the wound in it."

In discussing the whole of the question of the proper operation for aneurism, noticing this and other matters relating to Desault; he never alludes to that operation by which later authors have attempted to deprive Mr. Hunter of his just claim; and although he gives an account of Anel's operation, which remained unnoticed until Molinelli brought it forward to condemn it, he never calls Mr. Hunter's operation by any other name than that of Hunter.

It would appear then, that not only Desault's contemporaries were unjust to him, but that those who outlived him, for at least fifteen years, were equally so, including Bichat, the friend and pupil who edited his works, and wrote his eloge and biography; or the attempt of later French authors to attribute the merit of this operation to Desault, and to take it from Mr. Hunter, must be considered as a little piece of jealousy, unworthy of the great men by whom it has been made.

Mr. Hunter, from considering the manner in which the spontaneous cure of external aneurisms was effected, was led to propose and to practise, in 1785, the operation which justly bears his name. The merit of it however does not lie in the operative process, but in the principles on which it is founded. He saw that the principal dangers resulting from the old mode of operating, arose from the suppuration and ulceration which must take place after opening the aneurismal sac; and from the repeated hemorrhages which oc-

curred from placing a ligature on an artery in a state of chronic inflammation and disease. The means adopted by nature in the spontaneous cure of aneurism had convinced him that the contents of the sac, nay, the very sac itself, would be absorbed. The only point on which he required information was, whether the repeated hemorrhages which took place were really in consequence of the artery being diseased; and this he endeavoured to elucidate by observation and experiment. He laid bare the inner coat of an artery, by dissecting off by layers the two outer ones until he saw the blood through the remaining membrane; the wound was then closed, and the animal was killed three weeks afterwards, when the parts were found consolidated, the canal of the artery being neither increased nor diminished. This was not supposed to be sufficient to establish the fact, that an injury of the kind might be inflicted upon a sound artery with impunity; and Sir E. Home, after dissecting off the outer and middle coats in a similar manner, laid a piece of lint upon the artery to prevent adhesion, instead of closing the wound. It healed up at the end of six weeks, when the dog was killed, and the artery being injected, the coats of it were found of their natural thickness and appearance.

Satisfied by the result of these experiments, that ulceration of the artery depended more on its being previously diseased, than on the injury committed upon it, he fairly supposed that if he placed his ligature higher up on the artery on a sounder part, he would have a better chance of avoiding the hemorrhages which had so frequently proved fatal.

The only danger against which he thought that he might not be able to guard, was the opening of collateral branches into the sac and the artery above it, and he wished to avoid running into either extreme, of going too high in search of a sound artery, or of tying it too near the aneurism, where it would be diseased. He selected the middle of the thigh, as the spot for his operation; and the only improvement made since his time has been that of Scarpa, who recommended its being done a little higher up, where the vessel is more easily secured, without a greater chance of the collateral circulation being more free, so as to have any influence on the aneurism.

Mr. Hunter, in his first operation, placed four ligatures on the artery, all of which were drawn with various degrees of tightness. The patient was cured of his aneurism, but died of other complaints fifteen months afterwards The artery was taken out, and is No. 12 of the dried preparations in the Hunterian collection. The aneurismal sac is as large as an egg, and the lower opening into it was permanently closed. The wound healed before all the ligatures had come away, and so much inconvenience arose from their being discharged afterwards, without any perceptible advantage being gained from them, that in his second operation Mr. Hunter only applied one ligature. If this operation and its principle be compared with those performed by Anel and Desault, there will be seen to be little resemblance between them. The operation performed by Anel was forgotten, and it was done, not on a diseased but on a wounded artery, and close to the swelling. Desault's was done on a diseased artery,

was unfortunate, and was so far considered as an unsuccessful experiment, that it was never repeated by himself, although he lived many years afterwards; on the contrary, he adopted instead of it the operation recommended by Mr. Hunter. So far from its being considered as adding to his surgical reputation, no mention is made of it by his biographer and eulogist, who does however claim, as I have shown, merit for an operation never performed by him, and which will not succeed on the principles contended for, either by him or his successors. Mr. Hunter's operation was not an experiment; it was founded upon close reasoning, supported by experiments made for the purpose, and from long and continued observation of the powers and efforts of nature under similar circumstances. The names of Anel and of Desault have been, as it were, raked up with the hope of impugning the merit, the genius of Mr. Hunter. They have, on the contrary, rendered his name more illustrious.

The theory of the operation of Mr. Hunter, as performed in the present day, for aneurism, and applied to all the arteries of the body, is,

1. That the ligature be applied as far above the aneurismal sac as the first large branch or branches given off from the trunk of the vessel; and, if necessary from disease, even above them, so as to secure its application if possible on a sound part of the artery.

2. That the aneurismal sac will retain any blood which may be in it at the time of the operation, or any that may come into it afterwards, until that blood

has coagulated, and filled up the cavity of the sac, and the orifices of the vessels leading into it; a result which will inevitably take place, unless the collateral branches communicating with the artery above the sac are so large as to be able to pour the blood into it, with an impetus derived directly from the heart.

3. That the collateral branches, even when some have been cut off above the sac, are yet competent to carry on the circulation in the extremity.

4. That after the circulation through the limb has been re-established, and the blood been coagulated in the sac, the absorbents will remove it and reduce the sac to the state of a ligamentous and impervious cord, and restore the limb nearly to its natural state.

The objections to this operation are, not that the limb may fall into a state of gangrene, nor that the aneurismal tumour may suppurate and burst, or require to be opened (for these things take place more frequently in any other mode of proceeding); but that in consequence of the distance between the sac and the spot where the ligature is placed upon the artery, blood may and has been known to flow into the vessel and sac with such force as to maintain the circulation through it, and to admit of its increase; so that in fact the operation fails of attaining the desired object. This objection is a valid one. It was pointed out very early after the operation was tried in France, in consequence of an occurrence of the kind which occurred to Chopart. Deschamps, in reasoning on this case, says at once, that it cannot be obviated when it does occur, and that the operation will fail; but he acknowledges

that it is very unlikely to occur; and observation has proved, that unless the femoral artery has subdivided high up, and communicated afterwards below the ligature with its fellow, by a direct communicating branch, it is a most rare occurrence; and the very case in which it is admitted that it may take place is so uncommon, that there are not more than three or four instances of it on record. This lusus naturæ may generally be discovered before an operation is begun, if a due degree of attention be used in the examination of the limb; but it is so little expected to occur, that attention is rarely paid to it. The collateral branches may be so large, and so direct in their communication (without such a particular accidental occurrence as two superficial femoral arteries), as to maintain the circulation below the ligature, but this also very seldom occurs. It is not however uncommon for a pulsation to be felt in the tumour a few hours, or in a day or two after the operation, from this very cause, but it very rarely continues. The tumour gradually becomes firmer and harder, and diminishes in size; the pulsation daily becomes less perceptible, and at last ceases altogether, after which the cure is soon completed. If the pulsation should continue, and the aneurism increase in size, there is still a choice between the use of pressure made on the artery immediately above the aneurism, the old operation, and amputation; the former and latter of which, under such circumstances, will generally be preferred, more particularly if the aneurism is large, which will in all probability be the case.

Mr. Hunter was perfectly aware that such a consequence might ensue. It was clearly within his contemplation when he recommended the operation; for Sir E. Home, in giving an account of the theory and the manner of operating, does not say that he expected the supply of blood to the aneurism would be completely cut off; on the contrary, he only says, "The force of the circulation being thus taken off from the aneurismal sac, the progress of the disease would be stopped; and he thought it probable, that if the parts were left to themselves, the sac, with its contents, might be absorbed, and the whole of the tumour removed; which would render any opening into the sac unnecessary." The two following cases show the failure of this expectation. The first led to amputation and death. The second, under the care of Mr. Briggs, to a mode of treatment which was successful, and cannot fail to attract attention, as well as to be imitated in practice.

A gardener, forty-seven years of age, was operated upon by Mr. Gunning, in St. George's Hospital, on the 27th of April, 1821, for popliteal aneurism, which had appeared six weeks previously, was very painful, and accompanied by great swelling of the leg. The ligature came away on the 14th of May. On the 30th of June, he was dismissed as cured.

On the 20th of July, 1825, he was readmitted into the hospital, under the care of Mr. Jeffreys, and stated, that the tumour had entirely disappeared soon after he was discharged the hospital, in 1821. About five or six weeks before his readmission, he first ob-

served that the swelling had returned in the upper part of the ham, and was at that time nearly the size of a hen's egg. The tumour now occupied the lower third of the thigh, filling up the whole of the popliteal space, and projecting considerably on each side of the limb, between the hamstrings and the exterior muscles situated on the fore part of the thigh. It appeared to consist of three lobes, and was altogether as big as an ostrich's egg. The pulsation in the tumour was feeble, but distinct, and the skin covering it was of its natural colour. He did not complain of much pain. The limb was kept in the half bent position; and there was no swelling or œdema of the leg. The patient said that he was otherwise in perfect health, but he had a pale sallow complexion, far from confirmatory of his assertion.

A consultation was held on the case, and it was proposed to endeavour to get at the artery, between the part where it had been tied in the former operation and the aneurismal sac; and in the event of failure, to amputate the limb.

This was submitted to the patient's consideration; but as the first operation had not succeeded, he preferred undergoing amputation at once, rather than endure the pain and risk of two operations. In the beginning of August, he was attacked with a diarrhœa, for which he took a scruple of rhubarb, and five grains of calomel, which produced a most severe salivation, with such swelling and ulceration of the mouth, as to render it necessary to postpone the operation for several weeks. On the 5th of Septem-

ber, his mouth having got quite well, Mr. Jeffreys amputated the limb, between the tumour and the part where the femoral artery had been tied by Mr. Gunning. A large vessel, which appeared to be the femoral, and seven or eight smaller ones, were tied. Whilst the stump was being dressed, the man became faint and sick. After being put to bed, he complained of pain in the small of the back; a pillow was placed under him, which gave him relief, and he took thirty drops of laudanum. His spirits, however, did not rally; he told a fellow patient that he should never get over it. At seven in the evening, his countenance assumed a yellow hue, and at nine o'clock he expired, having survived the operation eight hours.

On the following day, the femoral artery and profunda were injected from the groin, and afterwards examined. The former vessel was found to be obliterated for the space of half an inch, at the part where the ligature had been applied four years ago; and immediately below it, two small branches were observed to enter the continued trunk of that vessel. These branches were equal to half the diameter of the femoral artery. The anastomosing branches given off above the obliterated portion were a good deal enlarged. The amputated limb was also injected, and afterwards dissected. The sac seemed to have been formed by the giving way of the internal coats of the artery, and the dilatation of its outer or cellular one; and it was inferred from the appearances, that the circulation through the aneurism had never been wholly

suspended, and that the disease in the last instance was a reproduction of the original tumour.

James Mack, carpenter, aged thirty years, in February, 1829, felt pain in the toes and ankle and knee, and afterwards a swelling like a pigeon's egg in the ham, which gave him great pain, particularly at night, and pulsated like his heart. The operation was performed on the 6th of March, by Mr. Briggs. The ligature came away on the 27th, the pulsation in the tumour ceased, and it diminished very much in size. It was only in June he was able to go to his work, when the swelling had entirely disappeared. In September it began to appear again with pulsation, both the swelling and the pulsation being soon greater than before. A compress was applied with a bandage on the part and on the leg, which made it worse. He then applied a hard compress, being in fact a narrow roller four inches in length, on the inside of the thigh, just above the knee, and above the inner hamstring muscles, which was firmly retained in that situation night and day. This gave him relief by taking away the pain, which was principally felt in the toes and ankle. This compress he wore for two months, at the end of which time the pulsation had ceased, although the swelling had not entirely subsided. He has gradually improved ever since, although he has still pain in the back of the leg, and on walking he feels the foot, and particularly the great toe, numb and cold. He cannot quite straighten the limb, and walks with a little halt. There is no appearance of the swelling now, one year after the operation.

Suppuration of the sac occasionally takes place

after the Hunterian operation, and is not uncommon when the aneurism is of great size. This can only occur in consequence of inflammation having been set up in its walls or exterior to it. It is by no means certain in which part it begins, but it invariably implicates both. If suppuration take place first exterior to the sac, and the abscess is opened, ulceration of the sac soon follows, attended by a discharge of its contents. If it be allowed to take its course, the contents of the abscess and the sac are frequently evacuated together. In such a case there is very rarely any hemorrhage: the inflammation which has been followed by suppuration has usually extended to the vessel itself, and coagulated the blood in it both above and below the tumour, if it has not completely obliterated these canals. When the old operation of laying open the sac was performed, only one ligature was sometimes applied, the surgeon depending on the compression made by the lint, with which the sac was filled, to prevent hemorrhage. When this came away early, bleeding from the lower orifice rarely took place, and it is not so much to be feared as extensive inflammation and suppuration of the surrounding parts. The sac should therefore be opened, as soon as it is evident that it will shortly burst if left to itself, and a free exit be allowed for its contents, as in the case of any other deep-seated abscess. If hemorrhage occur, the spot from whence it comes must be investigated, and a ligature, compression, or amputation must be resorted to, as the nature of the case or the state of the patient may seem to require. In a fair case, as regards the part, and the constitution of the patient, a ligature or compression

should always be tried before recourse be had to amputation.

If mortification occur, amputation should be performed according to the principles laid down in the third edition of my work on Gunshot Wounds, page 114, and to those which will be hereafter noticed in treating of mortification as a consequence of wounded arteries.

Effects of the Application of a Ligature to an Artery.

When a round and small ligature is duly applied to an artery of a large size, such as the femoral, the sides of the vessel are brought together in a folded, plaited, or wrinkled manner; the inner and middle coats of the artery are divided, the outer one remains apparently unhurt. If the ligature be removed, an impression or indentation made by it will remain as a mark; and if the artery be slit open in a careful manner, the division of the two inner coats will be obvious. These changes were known to Desault, and are mentioned by Deschamps in his work on the Ligature of Arteries. They were more satisfactorily proved to occur by Dr. Jones; and have been clearly stated by Mr. Hodgson and others. The remaining part of the process seems to differ from the account which they have given, and to be as follows. The inner and middle coats are not only divided, but the inner one particularly appears to be curled inwards on itself, so that the cut edge of one half or side is not applied to its fellow in the usual way of two surfaces, but by curling inwards meets its

fellow on every point of a circle, and in this way forms a barrier inside that of the external coat, which is tied around it by the ligature: so that in fact when a small ligature is firmly tied, its direct pressure is not applied to the inner coats, which have been divided by it, and have curled away from it, but to the outer one, which is in consequence of that pressure to ulcerate or slough. These processes could scarcely fail to take place also in the other coats, if they were subjected to it in a similar manner. The cut edges of the two inner coats, being from this provision of nature perfectly free, are capable of taking on the process of inflammation, which stops at the adhesive stage. This they do by the effusion of lymph, both within and without, to a greater or less extent as the case may require. The outer coat of the artery must either yield by ulceration or sloughing, or the ligature must remain until it is decomposed and destroyed. The artery usually yields by sloughing, but it does not always do so, particularly if a large one, and the ligature has been thick and soft. In this case, a part of the outer coat, from its folding or plaiting under the ligature, seems to escape that degree of pressure necessary to destroy it, and when the remaining part yields, it remains entire, and is only removed by a subsequent and slower process of ulceration, occasioned by its irritation as an extraneous body. I have had the opportunity and the misfortune of examining great numbers of stumps after amputation and death, and I have seen this occur in so many instances as to leave no doubt of the fact. I made a very fine preparation in 1816, showing a ligature retained in this way, the artery

above it being closed; and the ligature lying loose between it and the very extremity of the artery on which it had been placed, and which had not quite sloughed away; but I had the misfortune to lose it. In this, and other similar cases, the external coat could not close around the inner ones; and this shows that they are capable of forming an effectual barrier without it, although it materially assists in giving greater strength to the cicatrix, by the effusion of lymph which takes place within, without, and around it.

Whilst this process is going on without, and at the very extremity of the artery, the vessel is gradually contracting above it, and its coats become more or less inflamed, soft, and vascular. The inner coat is seen to be wrinkled transversely, and a coagulum of blood is formed within it. This sometimes completely fills the artery, but it is more common for a small tapering coagulum to be formed, adhering by its base to the lymph, which covers the cut extremity of the inner coat; the white colour of which renders it distinctly observable, when contrasted either with the coagulum, or the inner coat of the artery, which latter is usually of a red or scarlet colour, whilst the inflammatory action is going on. My observations have not led me to believe that a coagulum is absolutely necessary to the permanent closure of the artery, although it certainly assists in maintaining it. The artery is supposed to contract gradually up to its first collateral branch, but this depends entirely on the use for which the branch is required. In cases of amputation at the middle of the arm, the artery will go on diminishing in size up to the subscapular branch; the circumflex arteries diminish-

ing in proportion, in consequence of their being so much less necessary than before the operation. The rule, as a general one, will however hold good in an operation for aneurism, but I do not believe it to be so important as has been supposed. I have seen several instances in which the artery has remained pervious below the collateral branch, the next immediately above the part where the ligature has been applied. Neither will the presence of a collateral branch immediately above where the ligature has been placed upon the artery always interfere with the consolidation of the wound, and the closure of the canal of the vessel. It may impede the process, and render it for a time less safe, and in some instances it may prevent it altogether. I have so often seen large arteries heal after division close up to the giving off of a considerable branch, that I consider them to be always capable of doing so, provided they are naturally sound. If they are not sound, it is very doubtful what process may take place; but it will be less likely to be a healthy one, if interfered with by the greater proximity of the circulation. The power which suppresses hemorrhage in a bleeding artery, resides in the very extremity of the vessel itself.

A ligature should always be round and small; and the smaller the better, provided it be strong enough. The strength of a ligature is variously estimated; some surgeons trying it by the strength of their own fingers, others by what they conceive to be the resisting power of the coats of the artery, in which perhaps they may err. The only way in which a surgeon can hope to acquire correct information on this point is by

trying on the dead body what force of fingers is required to cut the inner coats of arteries of various sizes; and then taking the least force required for this purpose, to ascertain what is necessary to enable him to pull the ligature over, or off the divided end of the artery. If a surgeon will take the trouble to do this, he will find that he has estimated it much too highly, and that he is in more danger of doing mischief by breaking his ligature than by failing to secure the artery. Hemorrhage has however been known to occur from the ligature having slipped off the end of an artery, which had been divided in the operation for aneurism, although I have never seen it happen after amputation, where the vessels were tied with a small firm ligature. That it has taken place after the division of an artery in the operation for aneurism cannot be disputed; and although it may have arisen from some unavoidable accident, it constitutes a valid objection to the division of the artery between the ligatures, where two are applied.

A ligature composed of one thread of dentist's silk, well waxed, is sufficiently strong for any external artery; and two threads will be thought strong enough even by the most cautious. It does not however much signify what may be the shape, size, form, or substance of ligatures, when they are applied to arteries in a sound state; any thing will do, provided the artery be healthy, that it be fairly and separately tied, and with a sufficient degree of force to retain the ligature in its situation until separated by the usual processes of nature; which generally take from fourteen to thirty days for their completion.

When arteries are unhealthy, the selection and proper application of a ligature are points of great importance. A small round ligature should be fairly, evenly, and firmly applied, without the intervention of any substance whatever between it and the cellular covering of the artery. The secondary hemorrhages, which are recorded by different writers, took place more from the application of improper ligatures than from any other cause. These were generally large, flat, or irregular in shape; two, three, and four were by no means uncommon, one or two of which were left loose under the artery, ready to be drawn tight if wanted, a want which they themselves created by the irritation they produced, followed by suppuration and ulceration. The effect of a ligature was totally wanting, as far as regarded its application to the coats of the vessel; and the loose tape placed below it, called by the French the "ligature d'attente," had to excite inflammation in the artery by the irritation arising from the presence of an extraneous body. This was necessarily to be followed by ulceration of the whole of its coats, so as to allow a passage for the ligature through it. Under such circumstances, there was scarcely a possibility of a diseased artery taking on a healthy adhesive action; and with the ulceration of the coats of the vessel, hemorrhage took place. The artery had first to inflame, and its cavity to be filled with lymph thrown out from its inner coat, so as to render it impervious. Here the inflammation ought to cease, but under the continued irritation of the ligature it is scarcely possible that it should do this, or that the inflammation should not from the first proceed to the ulcerative state. That it

should do so under any circumstances, when arteries are suffering from chronic disease, is to be expected; and the Hunterian operation, performed at a distance from the aneurism, is founded on the principle of applying the ligature as far as possible from the diseased part. In few cases of aneurism, in old persons, will the artery be found perfectly sound, even at the most favourable distance for the operation. Some of the changes noticed in the preceding pages as alterations of structure will have commenced; but the inner coat is so prone to take on the adhesive state of inflammation, that if a proper ligature be applied in the manner directed, it is more than probable that the closure of the artery will be effected. Ulceration will however sometimes take place on the inner coat of the vessel, and slowly extend outwards, undoing in its progress any steps which may have been begun for the consolidation of the extremity of the artery. When a secondary hemorrhage does occur from this or any other cause, it is usually between the first and the fourth week; but there is no security for the patient until after the ligature has come away, unless it is retained an inordinate length of time from having included some substances which do not readily yield under irritation, such as the extremity of a nerve, or a slip of ligament, which is not compressed in the noose of the ligature.

Secondary hemorrhage, as far as relates to the vessel, is the consequence of a failure on the part of nature to close the canal in the artery by the adhesive process. It may also take place from the extension of ulceration or sloughing to the artery from the sur-

rounding parts, and perhaps as frequently as from any other cause; but when mortification occurs, there is no secondary hemorrhage, unless in that species which is called hospital gangrene. The advantages to be derived from the application of a small ligature, from the least possible disturbance of the surrounding parts, and from absolute quietude, whilst the healing processes are going on, must be so obvious as to require no further observation. Several cases will be adduced hereafter, in which secondary hemorrhage was the consequence of motion of the limb at too early a period; and an undue interference with the ligature, by pulling at it, cannot be too earnestly deprecated, as giving rise to it in a similar manner.

When secondary hemorrhage occurs to any extent, either through ulceration of the artery, or from the extension of ulceration or sloughing of surrounding parts to it, a ligature must be placed upon it nearer to the heart, and as far above the mischief which has taken place as the collateral circulation will permit; but the observations on the appearance of the blood and the manner in which it flows, made at page 137, should be strictly attended to. Many secondary hemorrhages may be restrained and ultimately suppressed by moderate pressure, and the ligature should only be had recourse to, when the application of pressure would appear to be, or has been proved to be, insufficient for the purpose.

Of the application of a Ligature on the Artery below the Aneurism.

This operation owes its origin to Brasdor and Desault, both of whom noticed it in their lectures; and the first idea of it is usually attributed to Brasdor, in consequence of Boyer having mentioned him first in his observations on this subject, vol. ii, p. 157. Bichat however, in his eloge of Desault, page 16, says, that Desault first conceived the idea of operating in this manner; and it is certain that it was first published in his works, although he had never an opportunity of practising it. Brasdor survived Desault, who died in 1795, and was present when the first operation of this kind was performed by Deschamps, who always refers the idea of it to Desault, and not to Brasdor. Under these circumstances, I am disposed to concur with Bichat in attributing it to Desault, who would appear to have first proposed it to his class about sixty years ago. Boyer, in the account which he has given of it, says that the first attempt to cure an aneurism on this principle was made by Vernet, who tried it by compression on the upper part of the femoral artery, but below the tumour, which however increased so rapidly in size, its pulsations also becoming stronger, that he was obliged to give it up, and confine himself to palliative means.

Deschamps performed the first operation on a case of femoral aneurism, in a man sixty years of age. The tumour extended upwards so close to Poupart's

ligament, as to leave only about the width of a finger between them, although in the first instance it appeared to be about five fingers breadth below the crural arch. Four days after the patient was admitted into the hospital (La Charité) the operation was performed by making an incision about the middle of the thigh. The artery could not be discovered, either by its size or pulsation, by Deschamps, or by any of the persons present. It was sought for in every direction; the sartorius muscle was even cut across, but in vain. It was then supposed that the artery must be in its proper place, and taking a nervous filament for his guide, which is usually found within the sheath (the saphenus nerve), he passed a ligature under what he considered ought to be the vessels, including a few fibres of the triceps muscle, and drew it as tight as possible. No alteration appeared to take place in the size of the tumour: no increase of size was observed. The operation lasted nearly an hour. The progress of the tumour had been well marked from the 10th to the 14th, the day of the operation, and it was not arrested on the 15th or 16th, when the swelling had reached the crural arch. On the 16th, the ligature, which appeared a little loose was tightened. 17th, no change. Night of the 17th and 18th, more pain in the thigh, and more particularly in the tumour, which was increasing in size.

On the 18th, the tumour was still increasing, the pulsations being the same, but the patient and the disease were now evidently in a worse state. The operation of opening the aneurismal tumour was decided upon, and performed at four o'clock in the afternoon. The

patient died apparently from loss of blood eight hours afterwards. On dissection, it was found that the ligature originally applied below the sac had included the artery, vein, and some fibres of the triceps muscle. There was a second aneurismal sac, one inch below the large one, the artery was otherwise sound; and Deschamps makes no remark about the absence of pulsation in the artery during the first operation, nor does he state the distance at which he tied it.

The second operation attempted on this principle was performed by Sir A. Cooper, in a case of aneurism of the external iliac artery, which extended into the abdomen, as high as the internal iliac.

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 that if its diminution continued, it would in a short time be possible to tie the external iliac above the tumour. The patient went into the country to recruit his general health, where the aneurism burst into the inguinal canal, and he died in consequence of the extravasation of blood into the cellular membrane of the pelvis and the scrotum. In this instance the femoral artery was tied below the origin of the epigastric and circumflexa ilii arteries; a current, therefore, Mr. Hodgson says, 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 a ligature of the artery at a distance from the disease. The parts were not examined after death.

Mr. Hodgson, in noticing this method of operating, page 291, 1815, says, "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, however, 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." He says, page 299, "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 hemorrhage 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 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: hemorrhage 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.

"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 third operation on the femoral artery below the tumour was performed by Mr. White. The case is mentioned at page 90. No diminution of size was perceptible on the application of the ligature, and it was unsuccessful in consequence of the inflammation and sloughing which followed. It was done in consequence of the success stated to have followed the revival of the operation by Mr. Wardrop in several cases, the first of them having occurred in 1825. These cases I must now allude to, as well as to the theory and opinions published by this gentleman in 1828; but as my wish is to avoid controversy, and not to exceed the limits of just and fair inquiry, I shall merely give an abstract of them, and refer to his book for the particulars; premising, that circumstances which have taken place since it was published have made a great alteration in the success supposed to have followed several of these operations.

Mr. Wardrop, coinciding in the opinion of Mr. Hodgson, as above stated, although contrary to that given by Mr. Allan Burns, performed the operation

on a patient of Mr. Glen's, in the year 1825, by placing a ligature beyond the tumour and below the bifurcation of the artery, in a case of carotid aneurism, which came so closely in contact with the clavicle as not to admit of a ligature being applied below it. The tumour diminished in bulk on the application of the ligature, and continued to do so until the fourth day. On the fifth and sixth there was a distinct increase in the size of the tumour, and it pulsated more strongly. This apparently unfavourable change was followed by a decided amendment, so that on the fourteenth day it was only about half its original bulk. The inflammation of the integuments continued, and ulceration took place. Several considerable sized portions of coagulated blood were discharged, along with some healthy pus, through the ulcerated opening, and the patient recovered. I am informed by Mr. Glen that she is now, nearly five years after the operation, in good health, and has not suffered any return of the disease.

In the second case of carotid aneurism, the tumour diminished after the operation, which was performed on the 10th of December, but did not entirely disappear, being of the size of an almond and pulsating strongly, until the patient's death, which took place on the 23d of March from disease of the heart.

In the third case of carotid aneurism, the operation was performed by Mr. Lambert, on the 1st of March. The tumour diminished in bulk. On the tenth day there was bleeding from the wound, the lower part of which was suppurating freely. The wound healed, and the swelling nearly disappeared. Mr. Lambert says, "All that can be felt on passing the finger deeply

down is a small hard tumour, having a very faint undulatory thrill. Five weeks after the performance of the operation, the cicatrix ulcerated; and on the 18th of April hemorrhage took place from it, which recurred at intervals, and destroyed the patient on the 1st of May. On dissection it was found, that the cardiac opening of the carotid artery into the aneurismal sac was perfectly closed by a firm coagulum of blood. The inside of the artery and sac was lined by a layer of fibrine closely adherent to it. The artery had yielded by ulceration just where the ligature had been applied, and the patient was lost through hemorrhage from the upper portion of the artery."

The fourth case of carotid aneurism was operated upon by Dr. Bush, now professor of anatomy in New York, but at that time assistant surgeon to the forces at Chatham. It was done in March 1826, and the woman is now, March 1830, alive and well. She required four small bleedings between the first and the fourteenth days after the operation, to keep down arterial action. The ligature came away on the nineteenth day, and the wound was healed on the twenty-seventh.

The fifth case of carotid aneurism, supposed to include also the arteria innominata, was operated upon by Mr. Evans, of Belper, in Derbyshire. A single ligature was placed upon the right carotid artery above the tumour on the 22d of July. On the 23d, the pulsation in the tumour was stronger than before the operation. On the 25th, the pulse was 120 and full, the right lip of the wound swollen and painful: six ounces of blood were taken away. 26th. In the morning,

pulse 92; in the evening, the pain and fever having returned, he was again bled. 27th. Not so well. 28th. Better. 29th. Appeared to be dying, and although conscious could only speak in a whisper. He was relieved by a profuse ptyalism, and in the evening he appeared to be as well as on the preceding day. He recovered, but the arteries of the right arm and fore arm, or of the affected side, became obliterated. Until the eighth day these arteries pulsated more forcibly than those of the unaffected side; but after the process of obliteration begun, the brachial artery was hard and painful to the touch, and felt very like an inflamed absorbent vessel. The right arm wasted, and became partially paralysed, from which he slowly recovered. The ptyalism which began the 29th of July, continued until the middle of September. In five weeks after the operation he was able to take daily exercise in a gig or on horseback. The disease was not however cured, as will be seen from the follow-communication from Mr. Evans.

"The history of Hall's case, as published in the Lancet of November, 1828, and Mr. Wardrop's book, is brought down to October 22d, exactly three months after the operation had been performed; from that time to the middle of June he continued rapidly to improve in health, and the tumour apparently remained stationary.

"Hall presuming upon the cure being complete, and contrary to the repeated cautions given to him, gradually resumed his usual habits: although h e didnot perform such extraordinary journeys as he had formerly done, he extended his rides to fairs and markets of

neighbouring towns, twenty miles distance from his home; and associating with his former friends, he was induced to participate in some of their irregularities. I heard now and then of his being tipsy, and having had one or two falls from his horse.

"About the middle of June he had a slight attack of catarrh, so slight that he did not think it necessary to call in any medical aid. Shortly afterwards, the tumour was observed to increase in size, in that part of cast (taken August 27, 1829) marked No. 1; it seemed to extend down the sternum, close upon the bone, covering the right sterno-clavicular articulation: in the course of the next six weeks, another tumour made its appearance (marked No. 2), on the other side of the sternum, covered by the left sterno-mastoid muscle, but evidently connected with the other portions of the tumour.

"August 27, 1829. The tumour now presented an irregular appearance, and seemed to consist of three parts or lobes; the middle and uppermost, being the original aneurism, felt hard and unyielding, as if it consisted of coagulated blood or fibrine; the second and third portions were soft and fluctuating; and there was an evident communication between the whole, for upon tapping any part of the tumour, it communicated a fluctuating feel to every other part of it, as if it were one large abscess.

"Since the 27th of August, the tumour has chiefly enlarged from its right side or lobe (No. 1): it appears gradually to extend itself downwards, inclining towards the middle of the sternum, without apparently producing any absorption of that bone; the left lobe of

the tumour enlarges more slowly, and extends laterally towards the left clavicle.

"There is not the slightest pulsation to be felt in any part of the tumour; by the stethoscope a distant deep-seated pulsation is heard, synchronous with the heart, unaccompanied with any particular noise; the pulsation is heard more distinctly with the naked ear; the same pulsation is heard along the course of the aorta to the heart; pressure has no effect in diminishing the size of the tumour; the breathing and deglutition are not affected, except when walking up a hill quickly. There is no apparent difference in the right and left subclavian arteries.

"The right hand and arm are nearly restored to their perfect use, though the limb altogether is not yet as large as the left. It is only very lately he has been able to write. His health is excellent, and he is capable of undergoing great fatigue.

"If I were to hazard an opinion I should be disposed to affirm, that the operation succeeded in arresting the disease for a time, and that under more favourable circumstances that time might have been prolonged; but the patient's return to his usual irregular habits, and the fatigue and exercise his avocations necessarily led him into, excited the disease in a lower portion of the innominata, or perhaps in the aorta itself, for the original tumour is yet easily distinguished from the later enlargements."

Mr. Wardrop, in his observations on these cases, seems to consider that the cure is accomplished on the same principles as in the Hunterian operation

for aneurism, *viz.* by the stagnation and subsequent coagulation of the blood in the sac, aided by the contractile power of the artery and sac; which it is conceived are capable of repelling the blood, and of causing its regurgitation into the great vessels leading to the heart. The comparison of this operation with that of Mr. Hunter is not however admissible. The essence of Mr. Hunter's operation consists in placing the ligature at a distance from the tumour, and on a part of the artery which may in consequence of that distance be sound. The comparison can only be admitted with the operation proposed and performed by Anel, and afterwards by Desault; and subject therefore to all the inconveniences and difficulties which Mr. Hunter proposed to obviate by his method, which can only be adopted when the artery admits of being tied several inches above the tumour. The theory on which these operations are founded is not the same, the effects are not the same, they cannot therefore with propriety be compared. It must also be recollected, that this method is chosen because the parts do not admit of any other, there being no space on either the subclavian or the carotid arteries to allow of the ligature being applied anywhere else than close to or near the tumour. Mr. Hunter's method was adopted principally for the purpose of avoiding two evils: one, the ulceration of the artery, which frequently took place from the ligature being applied on a diseased part; the other, the inflammation and suppuration of the sac, which took place from the inflammation extending to it and the surrounding

parts as a consequence of the operation in its immediate vicinity. Neither of these evils can be avoided when operations are performed on the carotid or subclavian, and rarely on the external iliac, and in fact they are always incurred. It does not appear that they can be avoided whether the ligature be applied above or below the aneurism, provided it be placed close to it; and in both cases it must be applied to an artery more or less diseased. In both, inflammation must take place to a greater or less extent, not only of the artery, but in general of the sac; and I shall venture here to say, that when the ligature is placed beyond the aneurism, the cure, as far as it goes, is effected by this inflammation, and not by the mere coagulation which takes place, as in the Hunterian operation. In reasoning on these points, I shall estimate the danger of inflammation and ulceration as equal, whether the ligature be applied above or below the tumour. Let us, however, suppose a case of a very long neck, in which the carotid can be tied on either side of the aneurism. When the ligature has been placed below the tumour, and nearer the heart, the current of blood being cut off, the regurgitating anastomosing branches bring blood into the aneurismal sac from the head and the other side of the neck, and some obscure degree of pulsation is experienced in it soon after the ligature is applied. Sir A. Cooper says that it was so in his second and successful case, Medical and Chirurgical Transactions, vol. i, page 229, and it continued for more than two months. He further adds, that he suspected the aneurism to be in the internal carotid; "for if

(he says) the aneurism had been of the external carotid artery, owing to the number of communicating vessels, I should not have been equally sanguine in my expectation that the pulsation would have ceased, as I have known two instances, one of a wounded radial artery, and the other of aneurism of the anterior tibial, in which the tumour continued to grow by anastomoses after the arteries had been tied above the swelling."

It appears then, when blood is brought into the aneurismal tumour above the ligature when on the carotid, or below when on other arteries, that the pulsation continues a long time before the sac is filled up by coagulated blood; and that in some cases it remains under these circumstances an enlarging aneurism. If this be the case, on what grounds can it be expected, that when the current is not cut off by a ligature applied on the main trunk, but is merely placed beyond it on the carotid, or below in the extremities, that the blood should coagulate, and the sac be obliterated? If regurgitating blood is capable of maintaining an aneurism, surely that which comes in with a full current must do the same. If then this were the whole of the question, it would admit of no doubt; but there are other things to be considered, which have been totally overlooked or neglected. In the first place, the only three operations performed on the femoral artery below the tumour have failed. In the first, by Deschamps, the aneurism never ceased to increase. In the second, by Sir Astley Cooper, it diminished at first, but ultimately burst, and destroyed

the patient by extravasating blood, which must have been fluid to get into the scrotum. In the third, by Mr. White, the tumour never decreased, but inflamed, and would have sloughed, if the patient had not been cut off by great constitutional irritation and fever. In Deschamps's case, no pulsation could be discovered in the artery, and it is more than probable that no blood was transmitted through it. In Mr. White's case the same thing took place, and there was no doubt on his mind or mine, that blood did not pass through it to the extremity. The ligature was then a matter of supererogation; it did nothing as far as regarded the stoppage of the circulation. I have already said, that if the works of surgical writers on aneurism be consulted, and attention be paid to the fact, it will be matter of surprise to find how many times it is stated, that the artery at the lower or further end of the aneurism was obliterated; and yet the aneurism increased. I have related or referred to several instances; and am therefore led to conclude, that in many cases of aneurism the lower end of the artery is diminished, and is often entirely closed; and to deduce from that, and the observations already made, that a ligature applied below or beyond the sac, as far as regards the ligature alone, or the suppression of the circulation, does little or nothing towards the cure of the aneurism.

The grounds on which it is argued that it has that effect are, first, that the tumour always diminishes in size, and it is presumed that the blood deserts the main trunk, provided no vessel is given off from or runs into the tumour; a point on which it is impossible to

give an opinion either way *a priori*. Although I admit that this diminution may sometimes take place, there is proof that in some instances it is not so, and that the tumour continues to enlarge; or if it should diminish at first, that it ultimately enlarges and destroys the patient.

It is also argued, that in a mechanical point of view the effect of a ligature placed upon a vessel, say an inch beyond the point where it gives off a branch, will be to cause the fluid in that part of the canal to cease to circulate, and be nearly in a state of stagnation; the quantity of fluid being also diminished in proportion to the degree of elasticity and collapse of the sides of the vessel. It appears to me that this argument, even if the facts are admitted, is decidedly against the new operation when compared with Anel and Desault's, inasmuch as it applies so much more directly to them. Surely the blood in an aneurismal sac is in a better state for coagulation, when it is only brought into it by regurgitation, than when it pours in with all the impulse of the circulation, one end of the artery in each case being closed. This seems so plain a mechanical fact that it cannot be disputed, so far as coagulation depends on stagnation. As to the effect of the elasticity of the sides of a diseased artery, it can scarcely be doubted that an artery which has only to resist regurgitating blood has much less to do than one which has to resist the whole current of the circulation. I am therefore inclined to say that the ligature, as a mechanical obstacle, is not quoad mechanical the cause of coagulation, when it takes place.

If the cases related are considered attentively, it will be seen, that in the first, the third, the fourth, and in Mr. Evans's, inflammation of the sac took place, and in some of them suppuration and evacuation of the contents of the tumour. If reference be made to other cases to be hereafter related, it will be seen that the same thing occurred, and that these aneurisms were cured in the same way as those which inflame, suppurate, and burst, in other parts and from other causes. The cure is then accomplished, not by the stagnation, and coagulation of the blood as a consequence of its stagnation; but as a consequence of the inflammation caused by the ligature having extended to the walls of the sac and the artery below it, or nearer the heart. This is proved by the dissection in the third case, in which the extremity of the artery nearest the heart was found to be firmly closed by a coagulum of blood about the size of a French olive. The coats of the artery, where surrounding the coagulum, were thickened to about four times their natural size, and lined with a thin layer of fibrine. These are proofs of the inflammation which had taken place, and they have been found in a case of a similar nature, to be noticed hereafter. I have not considered the second case as bearing upon the question, for as the whole of the carotid was found pervious on dissection, it is impossible to understand what changes had taken place in it.

The cure of an aneurism by the application of a ligature below or beyond the tumour, does not take place on the same principles as the Hunterian operation for aneurism. It occurs on the same principles which

effect a cure in the operation as performed by Anel and Desault, with the disadvantage of having a free current of blood flowing into it, which would certainly cause the aneurism to increase, if the inflammation did not extend from the part tied to the sac, and to the artery nearer the heart; giving rise by its effects on the vessel to the coagulation of the blood within it. The aneurismal sac without the inflammation would be in the same state as the aneurisms noticed in page 154, which increased after the Hunterian operation had been performed.

If reference be made to Mr. Warner, it will be found that he solved this question seventy years ago. He says, "C. D. was afflicted with a caries of the joint of the elbow, which was attended with such circumstances as rendered the amputation of the limb necessary. The operation was performed at a proper distance above the diseased part, and the vessels were taken up with needles and ligatures. In a few days, the humeral artery became so dilated above the ligature upon it, as to endanger its bursting. Hence it was judged necessary to perform the operation for aneurism, which was done, and the vessel secured by ligature above the upper extremity of its distended coats. Every thing now went on for some time exceedingly well, when suddenly the artery again dilated, and was in danger of bursting above the second ligature. These circumstances made it necessary to repeat the operation for the aneurism. From this time every thing went on successfully till the stump was on the point of being healed; when quite unexpectedly the artery appeared a third time diseased

in the same manner as it had been previously; for which reason a third operation for aneurism was determined on, and performed. The last operation was near the axilla, and was not followed by any relapse."

This case shows very distinctly, that where an artery is diseased, a ligature below or beyond it will not prevent its dilating and becoming aneurismal above it, unless the whole artery inflames and is consequently obliterated.

But in impugning the theory on which this operation is founded, I by no means intend to deny its utility, or the necessity for its performance. It ought to be done in every case of carotid aneurism, in which there is not space for the operation nearer the heart. The first case establishes this beyond all dispute; and although some doubt has been thrown upon Dr. Bush's case, as to the fact of whether there was really an aneurism, or only a bronchocele, I believe that it was an aneurism; and I know that the patient must have died if the operation had not been performed. I mention that such a doubt had been started, solely with the view of rendering the patient an object of attention to medical men, wherever she may be, for a reason which must to them be sufficiently obvious.

Mr. Wardrop, relying on the correctness of the theory by which it is supposed that the cure of an aneurism took place when the artery was tied beyond the tumour, has proposed to extend it to aneurisms below which a ligature cannot be applied, such for instance as aneurisms of the arteria innominata: and on the principle, that if the passage of a portion of the blood

which usually passed through an aneurismal tumour was cut off, by establishing a barrier beyond or below it, by ligature, the remaining portion would coagulate. He proposes in a case of this kind therefore to place a ligature first on the carotid, and then if necessary on the subclavian artery. I have already endeavoured to prove that a barrier formed beyond the tumour will not have the effect which he has expected from it, unless it is accompanied by an inflammatory action which is communicated to the sac, and through which the coagulation takes place. The preparations I have referred to, and the various cases I have instanced or alluded to, seem to put the point beyond doubt. Indeed if it were not sufficiently established, Mr. Wardrop's own book furnishes further proof, which cannot be disputed.

In the case of Mrs. Denmark which he published, supposing it to be a cure of aneurism of the innominata, which had been effected by a ligature placed on the subclavian artery, but who has since died of the disease, the fallacy of his theory seems to me to be most obvious. In this case (and I refer to his book, and to the Lancet, in which the report of the dissection is published, for the particulars), he and his friends in consultation presumed that the carotid of the same side was impervious, because no pulsation could be perceived in or through it; and the subclavian was tied under the supposition that the passage of blood through the aneurism was thereby rendered unnecessary, except for the supply of those branches which are given off at the commencement of the subclavian, and nearer the heart than the ligature. The blood

passing through the aneurism for this purpose, being calculated by himself to be about one-third of the quantity which passes through the innominata, a second third being allowed for the continuation of the trunk of the subclavian, and the remaining third for the carotid. On the ninth day after the operation on the subclavian was performed, the pulsation of the carotid of the same side became evident; and Mr. Wardrop supposes that it had not been permanently closed, but only pressed upon in a temporary manner by the aneurismal tumour; the partial diminution of which after the operation allowed the blood once more to pass through the carotid. It would then appear, that as the carotid is equal to the trunk of the subclavian at the part where the ligature was applied, nothing was gained, as far as regards the theory of the operation, by its performance; the same quantity of blood passing through it at one time as at another, subject only to the temporary interruption to one-third of its current, whilst the carotid was becoming pervious from the removal of the pressure caused by the aneurism.

The operation had the effect of diminishing the size of the tumour, causing it almost to disappear; it however ultimately enlarged, and appeared to lead to the destruction of the patient. The report of the dissection is as follows.

"The bulk of the aneurismal swelling had not diminished after death. On removing the integuments of the neck, the tumour occupied the central space between the two sterno-mastoid muscles, the sternal portions of each of these passing over the side of the

tumour. The mass may be said to have been composed of three divisions; one sternal, arising immediately above the sternum; another passed upwards along the trachea; and the third was the original portion of the aneurism, which had consolidated by the operation. These three masses formed in conjunction a lobulated tumour, larger than a turkey's egg. It had adhered firmly to the sternum, and had caused the absorption of a portion of that bone. The aneurismal tumour, as might have been expected from no diminution having taken place in its bulk after death, felt like a firm fleshy mass. On laying it open longitudinally, it appeared nearly solid. The coats of the tumour presented the usual appearances observed in true aneurism: the clavicular and tracheal portions of the sac were filled with firm coagulum, the cavity of the aneurism being chiefly limited to the division between the sternal and tracheal portions, and was about the size of a walnut. The layers of the coagulum were remarkably firm, and of a pale colour, being of a softer consistence and darker colour as they approached the boundaries of the aneurismal cavity. Heart:—the parietes of this organ were thinner and softer than natural, but no other change of structure could be perceived. The only change to be perceived in the aorta was that the coats had a deeper tinge of yellow than natural, rather thicker, and had a few small points of ossification. The size of the artery natural.

"On cutting into the innominata from the aorta, the aneurism was found to have originally extended from its origin to its bifurcation. The subclavian

artery is divided at the place where the ligature had been applied, and both the cardiac and distal orifices are contracted, and the sides of the vessel coalesce and adhere firmly together, so that a probe cannot be passed further along the canal than to within about a quarter of an inch of the distal end of the divided vessel. The right carotid pervious and quite healthy. The lungs healthy: the lining of the bronchiæ rather redder than natural, and contained a preternatural quantity of mucus.

"The preparation will be deposited in the museum of the College of Surgeons."

The preparation has not yet been deposited in the museum of the Royal College of Surgeons, and I have not had an opportunity of seeing it. It is possible that changes may have taken place, between the time when the operation was performed and the death of the patient, a period of two years and two months, giving rise to the appearances described; but I suspect that originally the aneurism was situated at the root of the arteria innominata, extending along the front of it, and then pressing upon the right carotid. I cannot understand, from a consideration of the preparations and cases of the kind that I have seen, how this artery could have been temporarily closed by pressure, unless in that manner. If the artery had been thickened from disease, it would have remained so: if it had been closed by a coagulum, it would have continued impervious. It has not been stated whether the branches of the subclavian given off nearer the heart than the ligature were pervious or not, which is an omission of great importance. It appears to me that

the operation gave rise to inflammation and consequent coagulation in the sac, which led to a diminution of its size, without interfering with the channel by which the blood passed into the right carotid. The disease was therefore for the time arrested; but as the artery was unhealthy in the parts surrounding the aneurism, it again returned, and ultimately destroyed the patient. The same thing is clearly taking place in Mr. Evans's patient. It is impossible to read that part of the case which I have published, page 175, without coming to this conclusion.

It is now necessary to inquire how far the communicating of inflammation to an aneurism so near the heart is a safe or advisable process. The following case, by Mr. Montgomery, surgeon to the Royal Navy, and to the Civil Hospital at the Mauritius, is illustrative of this point.

"A free black, about forty years of age, was admitted into hospital on the 20th of February, 1829, for an aneurismal tumour of the size of a pullet's egg, situated immediately above the sternal portion of the left clavicle, and so close to that bone, that it seemed to emerge from behind it, or rather from within the cavity of the chest. The poor man had an almost constant tickling cough, with severe pain of the trachea; copious frothy mucous expectoration; great anxiety of countenance; hoarseness of voice; disturbed sleep; and was rather emaciated from constant watching. The tumour rapidly increased until the 9th of March, when it had acquired an alarming size, the base occupying the space of two-thirds of the sternal portion of the clavicle, and ascending nearly

four inches upwards to the angle of the jaw, so that the volume of the tumour limited exceedingly the space for taking up the artery above it. The operation of placing a ligature upon the artery above the tumour was done after the manner recommended by Mr. Wardrop.

"March 10th. The patient suffered very much from dyspnœa, cough considerable and increased frothy mucous expectoration, and difficult deglutition for several hours after the operation, but which symptoms are now much abated. Pain of temple entirely gone; slept none in the night, for which he cannot account; pulse eighty, soft and full; tongue white, belly slow, the pulsation of tumour less distinct, and he feels in every respect much relieved. Ol. ricini ℥j. mist. mucil. pro tusse, vespere, well purged; haust. tinct. opii gtt. xxv. March 11th. Passed a tolerably good night; has less cough and irritation of the trachea; suffers but little from the wound or tumour, in which there is still pulsation, but less distinct than prior to the operation; complains of fixed pain of left scapula; pulse at the wrist eighty-eight, soft, tolerably full, and irregularly intermittent; skin natural; but little thirst. Mist. salinæ simp. ℥j, tr. digitalis, gtt. viij, 3tiis horis; for drink lemonade; vespere, continues to go on well; pulse seventy-two; no disposition to go to sleep, haust. tr. opii gtt. xxx. March 12th. Passed a good night; tumour much decreased in size; and says that the pulsation has entirely subsided, neither is it to be felt. Complains chiefly of slight difficulty of deglutition (but less so than at any period subsequent to the operation), with a fulness at the

epigastrium, and flatulent eructation. Voice more clear and distinct; pulse seventy-eight, soft and tolerably full, but still intermitting; no motion of bowels. Haust. cathart.; continue mixture and potus. March 13th. Has had but one scanty stool; slept none until an anodyne was given at midnight, after which he slept well till five o'clock. Pulse eighty, soft, tolerably full, and intermitting at longer intervals. The dressings being removed, the wound presented no appearance of union. March 14th. The aneurismal tumour is reduced to one half its original size, and does not pulsate when the patient is sitting up in bed. In the recumbent posture, however, an indistinct pulsation becomes perceptible. The patient is not sensible of any pulsatory movement in the tumour, but the wound has been painful, and caused a restless night. Bitter tonic mixt. ℥j. thrice a day; pil. hyd. gr. v. h. s. March 15th. A tolerably good night; bowels still confined; uneasiness of chest and epigastrium; pulse seventy, soft, full, and more regular; cough diminished; expectorates with difficulty; wound less painful. Ol. ricini ℥j. statim. mist. mucilag. pro tusse. March 16th. Bowels freely opened; all the symptoms less urgent; dressings removed; wound healthy; tumour diminishing. Contin. mist. mucilag. March 17th. Tumour continues to decrease; all the symptoms less urgent. March 18th. Tumour lessened; distinct pulsation perceptible at a small point on the humoral edge of the aneurism, indicative of approaching rupture of the sac; uneasy sensation of left side of chest; deglutition and cough much relieved; bowels confined. Ol. ricini ℥j. March 19th. Well

purged; passed a good night; wound dressed, and is nearly healed; ligature still attached; aneurismal tumour as yesterday; pulsation at the point mentioned less distinct; general feelings much improved. Infus. quassiæ ʒj ter in die, pil. hyd. gr. v. h. s. March 20th. Goes on well. In the evening slight hemorrhage from the wound, which, excepting where the ligature comes out, is entirely healed. Pulse much excited; general agitation and dread of approaching death. Pulsation at the point mentioned on the 18th more distinct, but nowhere else over the tumour. Haust. ex tinct. digital. p. gtt. xx; tt. camph. c. gtt. xl. March 21st. An indifferent night; no return of hemorrhage; pulsation at the point specified, still distinct; pulse irregularly intermitting; belly confined. Ol. ricini, ʒj. March 22d. Belly relieved; considerable return of hemorrhage at half past ten o'clock last night, followed by chills and total cessation of pulsation at the point alluded to, but which has returned since five o'clock this morning; pulse irregularly intermitting. At nine A. M. considerable bleeding from the wound; and at two and four P. M. bleeding incurred, but on every occasion was easily commanded. March 23d. A good night; no renewal of hemorrhage; aneurismal tumour more distended, pulsating considerably; pulse irregularly intermitting; belly confined. Pil. hyd. gr. v. h. s. March 24th. Slept none, bowels unopened; no bleeding; pulse eighty, soft, full, and more regular. Ol. ricini, ʒj. March 25th. Four copious stools; no hemorrhage; pulse eighty, soft, full, and regular; a good night; pulsation of aneurism lessened. March 26th. Continue as yesterday; dressed the wound,

which discharged pus slightly tinged with blood. Aneurism nearly of same size; no pulsation perceptible. Being watchful in the evening, got an anodyne. March 27th. Bowels torpid; otherwise as above; ol. ricini ʒj. March 28th. Twice purged; wound dressed; ligature came away with the dressings. Aneurismal tumour appears enlarged; deglutition again difficult. Mist. mucilag. ut antea. March 29th. A restless night; belly confined; tongue foul; ol. ricini, ʒj. From this period until the 3d of April, no change of importance occurred. At this date, a small abscess had formed in the course of the cicatrix, which discharged itself through the small opening left by the ligature, but by the 5th the discharge had ceased, and the opening specified finally closed. April 6th. Palpitation of the heart, and throbbing in the aneurismal tumour in the night; bowels confined; haust. cathart. April 7th. Purged freely; tumour painful in the night, but not pulsating. Pulse eighty-four, soft, full, and regular. May 28th. Since last report the general symptoms have been unimportant; the tumour gradually enlarged and threatened to suppurate, and the pointing prominence noticed on the 18th of March was so thin, as to cause apprehension of its bursting momentarily. The next day (May 29th) it gave way, discharging about eight ounces of fœtid chocolate coloured fluid. Compresses and bandage were applied to prevent the apprehended hemorrhage. On the 30th, these dressings, soaked with fœtid discharge, were removed; there being no sanguineous effusion, and perceiving the opening of the pointed tumour to be insufficient to give exit to the corrupted aneurismal

blood, I ventured to enlarged it. The incision being made, from six to eight ounces of matter similar to the above, mixed with coagula, escaped. I introduced my finger, and removed a considerable quantity of coagula and tenacious lymph. In the act of moving my finger for this purpose I felt the artery, below the seat of the ligature, without pulsation, the trachea pushed considerably to the right side, the anterior surface of the cervical vertebræ, and the muscles sterno-hyoideus and thyroideus as if dissected; the sterno-cleido-mastoideus rounded, and as if knotty, admitting the finger to pass round it. After clearing out the sac a dossil of lint was introduced, and adhesive straps with bandage applied. These dressings being removed on the following day, the lint was found covered with pus, but no discharge from the wound, which looked tolerably well. The swelling had very considerably subsided, the patient had passed a good night, breathed easier, coughed and expectorated less, and the pulse from one hundred and six had fallen to eighty-one. From this period the countenance and general condition of the patient improved; and every day's visit gave additional reason to hope for his recovery. The great size of the tumour may in part be accounted for by the decomposition of blood, and disengagement of gas. The fetor of the matter was such, that I could not remove it from my fingers for two days.

"At the present period (8th of June) the patient begins to walk out of doors: there is no discharge from the wound, which is on the eve of healing: all tumour has entirely disappeared from the neck; and what-

ever fate be in reserve for the patient, the aneurism at least seems to be cured.

"June 10th. The patient complains of stiffness of throat, with difficult deglutition, which was attributed to his exposure in the open air after previous long confinement. An anodyne was exhibited, and volatile liniment was used without good effect; on the contrary, the pain and stiffness extended to the right angle of the lower jaw. A blister was applied, and he was purged, with temporary relief. 13th. Slight purulent discharge from the wound; jaw continues stiff, with swelling of the parotid gland, and discharge of saliva from the mouth. Emollient cataplasms, astringent gargles, &c. 18th. Wound entirely healed; other symptoms continue. Continue poultice, gargle, &c. 26th. Considerable purulent discharge from the mouth, proceeding from the parotid gland, in consequence of which, the gland has become soft and decreased in size. From this period, tonic medicines, anodynes, and occasional aperients (as symptoms indicated), with a light nutritive diet, were given, and the cataplasm or hot fomentations and gargle continued. His health seemed to amend until two o'clock on the morning of the 3d of July, when he was suddenly attacked with cough, and expectoration of florid blood to the extent of six ounces, accompanied with sinking of the pulse, and every appearance of approaching dissolution. Sulphuric acid, mucilaginous mixture for the cough, &c. were given with some relief. The cough however continued, with expectoration at times mixed with blood, as also the discharge of purulent matter from the

mouth. The debility increased until five o'clock of the evening of the 11th of July, when he expired. At two the following day the body was inspected, in the presence of a majority of the gentlemen who witnessed the operation, and several others.

"DISSECTION. In order to expose the seat of the disease with the greatest accuracy, an incision was made from shoulder to shoulder, and another was carried from the centre of the chin to the sternum, dividing the integuments into two flaps, which were thrown up and backward to the angles of the jaw, the muscles separated from the clavicles and sternum, the clavicles separated from their articulations, and the sternum was removed after sawing through the ribs. By these means a perfect view of the parts in their relative situations was obtained.

"No vestige of the aneurismal sac remained; the artery and vein were obliterated, the former from its bifurcation as low as its origin from the aorta, between which and the arteria innominata, a distinct aneurism of the aorta of the size of an orange was discovered; the rupture in the vessel was completely closed by organized coagulated lymph, which had formed an obstacle to the further escape of blood from it into the sac, and in consequence of which, the contents of the sac had become putrid and offensive. The right carotid artery had become much enlarged. Thickening of the cellular substance surrounding the vessels; extensive adhesion of lungs; watery effusion into the cavities of the chest; pericardium distended and containing ten ounces of sero-purulent fluid; heart soft, its surface covered by a thick layer of a curdy looking

purulent matter, and coagulated lymph; inner membrane of the trachea rough and thickened; the bronchiæ filled with a frothy purulent looking fluid. An abscess containing about an ounce of ill-conditioned pus at the right angle of the lower jaw, with a destruction of the cellular substance surrounding it and the parotid gland.

"The morbid appearances were such, that it is wonderful how the patient survived so long; and although the fatal termination of the case was contrary to my most sangnine expectations, the dissection proved the success of my operation: the artery obliterated, the sac wanting, and no communication between it and the sac of the aortic aneurism."

Mr. Montgomery will, I trust, pardon me for dissenting from his conclusions; and I beg he will believe, that I only do so because greater opportunities of observation have enabled me to take a more comprehensive view of that part of the question which is not entirely practical.

An aneurismal sac of the size described in the first part of the case never could disappear in four months, by any of the processes of nature, or after any operation performed for its cure, with which we are at present acquainted; more particularly as the remains of the artery and vein were discoverable although obliterated, by which I understand them to have become impervious. There never was then an aneurism of the carotid; but the aneurism which was found to exist between the origin of the left carotid and the innominata had formerly extended up the neck so as to resemble an aneurism of the carotid. The operation on the carotid

gave rise to inflammation, which extended first to the arch of the aorta and to the aneurismal sac, and afterwards along the aorta to the heart and pericardium, which in the end destroyed the patient. It is impossible to read the case with attention without perceiving the progress of the inflammation, from the application of the ligature to the death of the patient. The inflammation not only caused the coagulation of the blood in the aneurism, the suppuration of the sac, and its subsequent bursting, but it filled up the opening into the aorta. If the inflammation had stopped here, a cure might have been effected; but it did not do so, and the probability of its ever ceasing at a desired point is not great. In the case of Mrs. Denmark and of Hall, operated upon by Mr. Evans, it appears to have done so, but the disease returned in both instances. Too much inflammation kills the patient. Too little is insufficient to effect a cure. It must always be a matter of doubt how far the supervention of acute inflammation, on a part in a state of chronic irritation or inflammation, which have led to alterations of structure, can cause them to be restored, or to return to their previous or natural state; for unless it does this, the disease can only be temporarily arrested under the most fortunate circumstances, but not subdued or removed.

The preparation No. 371 B, page 62, shows an aneurism of the arch of the aorta, close to the innominata, which was mistaken for it, and could not during life be in any manner distinguished from it. An operation, if it had been successful in arresting the progress of this aneurism, could have had no influence on the others existing in the aorta below it. It might

have delayed the death of the patient, if it did not hasten it.

The preparation No. 411 B, shows an aneurism arising from the anterior part of the arteria innominata, and extending up the neck, so as to touch the lower part of the thyroid cartilage. The right carotid and right subclavian are seen coming off from the lower and back part of the tumour, and are pervious. The root of the innominata is slightly but preternaturally enlarged, as well as the arch of the aorta. The external coat has been removed at this part, to show the middle one; and portions of the middle coat have been also taken away, to show the inner one; but their natural structures are not traceable beyond the commencement of the tumour.

It is impossible to look at this preparation, without being satisfied that it might have been mistaken for an aneurism of the carotid; and in all likelihood it was so. The carotid and subclavian arteries are both pressed out of their proper course; and it is very probable that little blood was sent through them, and that the pulsation in them was indistinct. An operation on either could have done nothing, unless it gave rise to inflammation in the sac, inasmuch as there is little communication between them.

The Baron Dupuytren has performed the operation once for subclavian aneurism by placing a ligature beyond the tumour. The operation was done on the 12th June. The aneurism was of six months standing, and about the size of a hen's egg. It occupied the situation of the right subclavian artery, from its exit between the scaleni to the clavicle upwards,

and outwards towards the trapezius it projected considerably. The axillary artery seemed sound. The pulsations at the commencement of the subclavian, and of the arteria innominata, were strong, large, and seemed to indicate a dilated state of these vessels. General health good. A ligature was placed on the axillary artery below the clavicle; the operation being performed with the utmost coolness, precision, and judgment.

June 15th (third day from the operation). Aneurismal tumour diminished in size, but the pulsations are as strong and superficial as before. No fever. Compresses, wetted with a weak solution of acetate of lead, were applied to the tumour, and covered by a bladder filled with pounded ice.

17th. The limb retains its natural heat and colour. Patient appears agitated. Pulse quick and frequent. Tumour has been much disturbed by some violent fits of coughing. Blood was drawn from the arm. In the middle of the day, some bleeding took place from the wound, perhaps to the amount of five or six ounces, but which ceased after washing the wound with cold water. Bled again, and appeared much weakened.

18th. No hemorrhage. Bled again.

19th. Bottom of the wound appeared swollen, as if the aneurismal tumour had made progress in that direction: v. s. The pulsations in the tumour above the clavicle continue the same. The operation has not, therefore, produced any other good effect than that of lessening the size of the tumour. Died at four o'clock in the morning of the 21st

Dissection. The right arm, being that of the side operated upon, presented a livid and gorged appearance; numerous livid veins were perceptible, and the cuticle was raised at various points. A pupil who had been almost constantly with him, stated that the arm underwent no particular change, and that the colour and temperature remained the same to the last. Neither in the head nor abdomen were there any appearances at all remarkable.

Thorax. The first and second ribs, on which the tumour rested, were absorbed, and at one point entirely destroyed. The right and left cavities contained about eight ounces of sero-sanguineous effusion, of deep colour. The heart was flaccid and empty: it was very large, the parietes being attenuated rather than hypertrophied. The pleura investing the back part of the right lung was inflamed; false membranes of inconsiderable thickness appeared on its surface. The lung of that side presented numerous points of hepatization. The aorta, from its origin to within three fingers breadth from its passage through the diaphragm, was enormously dilated. The walls were very thick, and the internal surface of a livid red, having at numerous spots fungous growths, erosions, and asperities, proceeding from very hard ossifications. This great change in the structure of the aorta, ended suddenly at the ventricle. The subclavian was diseased throughout its course. The tumour formed by it extended beneath the clavicle, passing behind the axillary artery, which at this point was flattened; backwards, it reached as far as the superior spinous fossa. Although it had undergone

a perceptible diminution since the application of the ligature, both in this and in the other directions in which it had extended during life, no perforation was discovered in it. In the aneurismal tumour there were but few clots, except in front, where the greatest dilatation existed; here there were numerous depositions in thin layers; there were also some at the bottom, but not so many. No trace of the arterial parietes could be discovered beyond the internal of the scaleni muscles. Beneath the clavicle, the three tunics of the vessel could be traced, and presented the alteration above described as existing in the aorta, *viz.* an appearance of fungous irregularities. The constriction exercised by the ligature, which was of silk, did not appear to be very great. In one point of the circumference of the artery a small opening was found, which was attributed to the pulling of the ligature during the dissection of the tumour. The inner membrane was cut in some places, but not in others. There was no trace of coagulum, and the whiteness of the membrane showed that no inflammatory action had taken place in it. The vessel was sound throughout the rest of the limb. The axillary vein at the situation of the ligature was black, fungous, and softened, and torn with the greatest ease.

The following case, related by Mr. Mackelkan and published by Mr. Wardrop, is so decisive that I extract it entire.

"T. Gordon, a blacksmith, thirty years of age, whose general health was good, after exposure to wet and cold, was seized with violent vomiting; during which, to use his own expression, 'a swelling sud-

denly started up in the hollow of his neck.' I saw him fourteen days after this attack: he then complained of what he considered to be a rheumatic affection of the right arm and side of the head: two days afterwards he mentioned the swelling in his neck, which he requested me to examine. I then found an aneurismal tumour, of the bulk of a hen's egg, in the space between the clavicular portion of the mastoid muscle and the edge of the trapezius; and I could trace the base of the tumour, extending downwards and inwards behind the clavicle. In this state the patient was advised to go into the Middlesex Hospital, where he remained six weeks, and during which time Valsalva's system of treatment was pursued with the most unwearied diligence. On his return home, I found the aneurism had increased to four times the size it was when I had first examined it, and the symptoms were much aggravated from the bulk which the tumour had attained, and which now greatly impeded respiration. From this state he sunk rapidly, and died on the following day.

"Dissection. The appearance of the neck was very different from what it had been during life, the tumour not being above one-third of its former size. When the whole of that part of the tumour situated in the neck was exposed, there were three subdivisions observable; one extending upwards by the side of the trachea, as high as the cricoid cartilage; a second laterally along the line of the clavicle to one-third of the extent of that bone; and a third between these two, extending upwards and outwards across the neck to the anterior edge of the trapezius muscle. The

structure of the coats of the sac at its anterior aspect gave way immediately on touching them. The upper part of the sternum and cartilages of the first and second ribs being removed, the remainder of the tumour was exposed, extending behind the clavicle and upper part of the sternum, and reaching to the arch of the aorta, upon which it rested. The tumour being slightly raised, the innominata was divided close to the aorta, and the diseased parts removed. The carotid was found behind the first portion, and the subclavian behind the second, and towards its lower part the orifice of the innominata was perceived. On examining the cavity of the sac, the aneurismal opening was found to be in the arteria innominata, about an inch in extent, commencing at about half an inch from its origin, and reaching to its division, the coats retaining their healthy appearance, and this appearance terminated in an abrupt line where the parietes of the aneurismal sac commenced. At the lower part of this space, the orifice of the innominata was seen; at the upper part, and towards one side, that of the subclavian. No carotid could be here discovered; but on passing a probe along this artery from above, resistance was offered to its progress at about half an inch from the point where the vessel might be expected to open into the sac: this, however, was overcome with a slight force, and the instrument passed on till its point was perceived through a semi-transparent membrane which was stretched over the orifice of the artery, and appeared to be continuous with the living membrane of the innominata, preventing the passage of the probe into the cavity of the sac. Between the

tumour and first branch of the subclavian was a portion of the vessel half an inch in length, and perfectly healthy. A coagulum about the size of a walnut occupied that portion of the sac behind the upper part of the sternum, and layers of the same nature, about the thickness of half an inch, were found at the upper and inner part, where the tumour was in contact with the trachea."

In this case, the aneurism went on increasing until it destroyed the patient, although (as it was proved after death) the carotid had become impervious, by a process of nature unassisted by art; proving that such a barrier to the passage of one-third of the blood usually sent through the aneurism or artery, had no curative effect whatever. It is impossible to refrain from inquiring, "*Of what use would this obliteration of the artery have been, if it had been the effect of an operation?*" The answer is evident, "*Of none whatsoever, quoad the formation of a barrier,* or the closure of the vessel." But it might have been of very great temporary use, if it had been followed by inflammation of the sac and the coagulation of its contents.

The theory which Mr. Wardrop has attempted to set up, was long since shown by Mr. Hodgson not to be tenable in regard to iliac aneurisms, when the ligature was applied below the epigastric and circumflexa ilii arteries. I trust I have demonstrated it to be equally inapplicable to aneurisms of the innominata, whilst I have at the same time shown that the only principle on which these operations can either do good or harm is by the extension of inflammation.

It must be recollected, that in two out of the three

cases of aneurism of the iliac artery, in which the operation was performed below the tumour, the disease continued to increase, and destroyed the patients. The third died early from inflammation and sloughing. The reason hitherto assigned for the failure of these operations, is, that the epigastric and circumflexa ilii arteries remained open, and that in consequence the circulation continued through the aneurism. Now this reason must be abandoned, or it must be admitted to have at least an equal degree of validity with relation to an aneurism of the subclavian artery, from which one-third only of the current of blood is supposed to be cut off, whilst certainly two-thirds are cut off from the iliac aneurism by tying the artery below the organs of the circumflexa and epigastric arteries.

I shall conclude by the following summary:

1. Whenever the operation for aneurism succeeds from placing a ligature below or beyond the tumour, it does so by giving rise to inflammation in the aneurismal sac and in the artery both above and below it; and unless it does this it fails.

2. That this operation, as well as all others, is exceedingly dangerous in the vicinity of the heart, from the facility with which the inflammation may be communicated to that, as well as to the neighbouring organs.

3. That it will not effect a cure, in cases of aneurism of the innominata or arch of the aorta, although it may give temporary relief by the partial diminution of the tumour.

4. That being as likely to destroy the patient as to give this relief, it ought never to be performed until

the life of the patient is in extreme danger from the size of the tumour, when the person may have the opportunity of choosing between a more sudden death or a temporary relief; but the chance of a cure should never be calculated upon.

I have watched two cases of aneurism, supposed to be of the innominata, for the last two years, on both of which it had been proposed to perform this operation, but which the patients refused to undergo. They are still nearly in the same state; and although in many instances the disease proceeds with rapidity, it is in others slow in its progress, occasionally receding and again increasing in size, until at last a new impulse seems to be given to it, which tends rapidly to a fatal termination. It is then only that an operation of this nature should be thought of, and the result, even as to temporary relief, must always be very doubtful.

OF

WOUNDS AND INJURIES OF ARTERIES.

A VARIETY of experiments have been made by different persons on the arteries of dogs and horses, in order to observe the processes which take place in them to effect a cure, or which precede the dissolution of the animals. This has been done with the view of elucidating the manner in which these processes are supposed to take place in man, under similar circumstances; but the analogy, however specious, is not satisfactory, inasmuch as it is distinctly seen, that the injuries of arteries in man do not follow the same course as in animals; and the means which nature adopts to effect the cure of an injury in animals, cannot be considered to take place in man, as it is not followed by the same effects. This should not be regarded as in the slightest degree extraordinary, when we reflect that they are not liable to the same diseases; that there is a difference in the nature, and in the coagulability of the blood, in the force by which it is impelled, and in all probability in the nutrition, if not in the formation or structure of the artery. Some approach however may be made to the truth, by consi-

dering what does take place in animals in cases of punctured wounds or of complete division of arteries.

If the femoral artery of a dog, or the carotid artery of a horse, be laid bare, and punctured by a large needle, blood oozes slowly through the opening, and after a little time coagulates on its surface. If the sheath is not laid open, and the artery is only punctured through it, a small tumour forms of the effused blood, like a circumscribed aneurism. The wound soon heals externally, and on examining the artery four or five weeks afterwards, little or no sign of injury will appear.

If a longitudinal slit, the twelfth or even the sixth part of an inch, be made in either of these arteries, it will heal without any mark on the inside of the vessel; and in some instances even when of a greater extent, provided the opening in the sheath has been only of similar dimensions.

When the artery is divided transversely for one quarter of its circumference, the edges of the wound are unequally contracted, so as to form nearly a circular opening; the hemorrhage from which is sometimes great, and often returns on the slightest exertion until death takes place. If the artery has not been denuded, a coagulum forms in the sheath, which adheres to the artery, and fills up the circular opening. After five or six weeks, the circular opening has become a mark on the inside, evidently a cicatrix.

When the artery has been divided to one half of its circumference, it has been known to heal and remain pervious, but in almost every case the animal dies from repeated hemorrhages. Where three-fourths of the

artery are divided, the slip which remains prevents the retraction of the under part of the artery, but the upper parts are separated to a considerable distance, giving to each the shape of a pen cut for writing. When the animal does not bleed to death, this slip is either torn through or destroyed by ulceration, and the ends of the artery are found retracted, and completely separated from each other. The layer of coagulum thrown out in all these cases is not confined to the part, but extends upwards and downwards for several inches in the sheath, and in a similar manner in the cellular structure between the muscles external to it. It is however thicker immediately over the wounded part, as if the blood last effused had coagulated immediately from the slowness with which it was poured out, whilst a certain quantity is interposed between the edges of the incision and the artery itself.

This coagulum or clot undergoes certain changes: at first it adheres to the cut edges of the artery, but these soon inflame, and throw out coagulable lymph or fibrin, which is of a yellow, or yellowish green colour, and this matter now adheres to and surrounds the clot; the red colouring matter of which is afterwards removed, with a portion of its constituent parts, until it assumes the appearance of an organized whole. Whilst this is going on, lymph is thrown out from the surrounding parts, which adheres to them very tenaciously. If there be an external opening, the coagulum of blood is dissolved and removed to make room for this lymph, which is soon to become the bond of union between the surrounding parts, and from which the

necessary growth takes place. The yellow greenish colour of this effused matter always marks the place where an artery has been wounded or divided.

The matter effused within the edges of the artery becomes organized, and unites these edges so perfectly as to leave no mark, being itself removed as soon as this object is effected. In other instances, a small part remains, which does not appear to become so strong or resisting as the natural coat of the artery, and often yields, forming a true aneurism in man.

The processes of reparation in man are by no means so favourable, as far at least as observations made on injuries of arteries will enable us to judge. It is probable, that a simple puncture made with a needle, will sometimes heal as in animals; but I have seen two instances in which the femoral artery was wounded by a tenaculum, and ulceration followed by hemorrhage took place in both, requiring the application of a ligature: but it is certainly otherwise with a longitudinal fissure, of from one to two lines in extent. The edges of the wound do not separate when the artery is in its natural state, so as to allow of a jet of blood from it. On the contrary, it only oozes out, and sometimes not even that kind of bleeding is perceptible, until some obstacle to the circulation takes place below, when it is propelled with a jet; and having begun, and the edges of the cut having been separated, it continues to be thrown forth in considerable quantity. When once suppressed by pressure above, the circulation through it may and often is again carried on for several hours without further hemorrhage, when it may recur without any obvious cause.

Wherever I have seen a slit in a large artery, I have always placed a ligature upon it; and am not competent from my own knowledge to show the manner in which such a wound heals in man; but there can be no doubt that in an artery like the temporal, a longitudinal slit heals, without the canal of the vessel being obliterated. In larger arteries, when I have known them to be wounded, and a cure has taken place through the efforts of nature, unassisted by art, the canal of the artery has been obliterated. The precise nature of the wound could not of course be ascertained.

When an artery is cut transversely in man, to one-third or fourth of its circumference, it forms the same circular opening as in animals; and if the artery is large, the bleeding usually continues until the person faints, or it is arrested by pressure. The difference however between the arteries of man and of animals is here most strongly exemplified. In an animal, the bleeding will probably be restrained altogether, without any assistance from art. In man, even with the best assistance in the way of compression, unless the circulation be altogether stopped, hemorrhage will in all probability recur, and if the external opening be closed, a spurious aneurism will be the consequence. This is often seen in so small an artery as the temporal, and I have been obliged to apply a ligature above and below a tumour of this description. When it has been of a smaller size, I have merely divided it transversely, and applied pressure; but this is dangerous, from being so liable to derangement, when the hemorrhage will

often be considerable, whilst the patient must remain in a state of anxiety for several days.

No reliance can be placed in man on the efforts of nature in healing a wounded artery; neither will observation permit of any expectation being formed of such an occurrence taking place. I by no means intend to imply, that a wounded artery will not heal by the efforts of nature alone, for I know full well the contrary; but I do mean to say, that such an event should never be contemplated after the recurrence of hemorrhage from it, and that art should then come to the assistance of nature in the most effective manner that the state of the case will permit.

When an artery is completely divided, it is less likely to continue to bleed than if it had been only wounded; and a variety of opinions have been entertained on the subject of the means employed by nature for the suppression of the hemorrhage, as well as of those recommended by art, which it is necessary now to notice.

Celsus, Rufus, Galen, Ætius, recommended the artery to be cut across, and a ligature to be placed on both extremities; or that it should be secured by ligature higher up on the trunk, and then divided below, something after the manner of the operation described by Ætius for aneurism. Galen was acquainted with the method of cure by compression, and gives a case in which it succeeded in the brachial artery. Saviard states, in his work De Aneurismatibus, that he had known a case of wound of the brachial artery remain sound for twenty years, when the artery yielded at the cica-

trix, and gave rise to hemorrhage, requiring the application of a ligature.

It is to Petit however that we are indebted for the first scientific investigation into the means adopted by nature for the suppression of hemorrhage. He supposed, that a clot of blood was formed within the vessel, which he called the *bouchon* or cork, and another portion without, which he termed the *couvercle*, or covering. The internal clot he believed to be in general small. The coagulum covering the wound in the artery was larger, and might be retained in its place by a compression so slight as not to interrupt the circulation. Hemorrhage was, he conceived, arrested with difficulty only when the external clot was not well supported: but he confined his expectations of success to cases in which only a sixth, or at most a fourth part of the artery had been divided. The clot he considered as adhering to the lips of the wound and to the surrounding parts, and to be of the same nature as the substance forming cicatrixes generally. In proof of which he showed to the Academy of Sciences in 1732 the brachial artery of a man who died two months after it had been wounded. The wound was filled by a clot which adhered to its circumference: maceration for two months in water, and for three years in brandy, had caused no change in its characters.

When the wound in the artery was larger, he was aware of the necessity which existed for the application of a ligature, and for the formation of a coagulum above it, depending in shape on the form the artery

received from the ligature. That a wound after bleeding in the brachial artery should heal under compression, was known to his predecessors and contemporaries, cannot be disputed. Lancisi had previously noticed it; and Foubert, Garengeot, Trew, and others, recorded similar cases.

Morand, in 1736, entered more particularly into the consideration of this subject, and added some points to those already indicated by Petit; principally, that the changes which the artery undergoes assist in suppressing the hemorrhage. He attributed much of this effect to the retraction and contraction of the vessel; and although the manner of expressing the fact does not quite accord with our more modern ideas, still the fact remains, and cannot be controverted. Justice has not in fact been done to Morand, and his opinions have been frittered away under the idle criticism, that he attributed longitudinal fibres to arteries, when none can be demonstrated. It would be difficult however to show the manner in which an artery shortened itself, on being divided, without admitting that fibres of some sort did diminish in length. What he attributed to longitudinal fibres, is now allotted to the diagonal elastic fibres of the external coat. He proved at least that the contraction of the artery, and its gradual diminution of size from the extremity upwards, decided the form of the coagulum contained within.

Sharp, in 1739, maintained a similar opinion.

Pouteau, unfortunately for the credit of his character for correct observation, denied the retraction of the artery, or the formation of a coagulum within it, as

essential occurrences. When they did take place, he considered them in the light of accidental and subsidiary means, and supposed that the swelling of the cellular membrane around the extremity of the divided artery, formed the principal obstruction to the flow of blood through it.

Kirkland in 1763, Gooch in 1766, White, and Aikin, opposed the opinions of Petit, and adopted in some degree the theory of Pouteau, mingled with the statements of Morand; denying first the fact of a coagulum being formed within a divided artery, and confirming the observations of Morand with reference to its contraction.

Kirkland's opinions may be summed up in a few words:—

1. That hemorrhage from a considerable artery is easily and effectually suppressed by only making a perpendicular pressure upon the end of the vessel for a few minutes.

A statement that was overlooked or neglected by his successors, but which is nevertheless essentially correct.

2. That the pulsation, at first, is very plainly seen at its extremity, but after some time it becomes less perceptible.

This is also a fact, which will be admitted by every one who has had occasion to open a stump even one hour after amputation, on account of secondary hemorrhage; whilst the reverse is also proved, by the same investigation, to take place in arteries which have not undergone the processes which give rise to its suppression.

3. That the bleeding is not suppressed by a coagu-

lum, but by the vessel being closely contracted for nearly an inch from its extremity. That the artery gradually contracts and becomes obliterated up to the nearest collateral branches, which dilate in proportion, and that the mere intercepting the passage of the blood through the artery for a short time, was all that was required to effect these objects.

Mr. J. Bell thought, "that when hemorrhage stops of its own accord, it is neither from the retraction of an artery, nor the contraction of its fibres, nor the formation of clots, but by the cellular substance which surrounds the artery being injected with blood."

We come next in order to the opinions of Dr. Jones, whose work on the processes employed by nature in suppressing the hemorrhage from divided and punctured arteries, has been considered so complete and conclusive in this country, that few persons have questioned either its accuracy or that of his conclusions. It may be permitted however to observe, as a circumstance rather remarkable, that he should criticise Mr. John Bell for calling the means employed for the suppression of hemorrhage *natural*, when he recommended as an auxiliary, a certain degree of pressure to be made by the end of the finger; and yet, in a set of experiments made expressly to ascertain the means adopted by *nature*, he himself, in fourteen out of nineteen of them, actually closed the wound made for the division of the artery by ligatures, and considered that to be a *natural means!* invalidating thereby every one of these experiments, as far as natural means, totally unassisted by art, were to be the subject or object of consideration. I shall give

his opinions at length, and then discuss those points in which I consider he may have been in error. He says, alluding to his experiments,—

"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 natural impulse, however, with which the blood is driven on, in some measure counteracts the retraction, and resists the contraction of the artery. The blood is effused into the cellular substance between the artery and its sheath, and passing through that canal of the sheath which has 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 fibres 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 certain degree of obstruction to the hemorrhage, which results from the effusion of blood into the surrounding cellular membrane, and between the artery and its sheath, but particularly the diminished force and velocity of the circulation, occasioned by the hemorrhage, and the speedy coagulation of the blood, which is a well-known consequence of

such diminished action of the vascular system, most essentially contribute to the accomplishment of this important and desirable effect.

"A coagulum then, formed at the mouth of the artery, and within its sheath, and which I have distinguished in the experiments by the name of the external coagulum, presents the first complete barrier to the effusion of blood. This coagulum, viewed externally, appears like a continuation of the artery; but on cutting open the artery, its termination can be distinctly seen, with the coagulum completely shutting up its mouth, and inclosed in its sheath.

"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. This coagulum is distinct from the former, and I have called it the internal coagulum. 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 hemorrhage chiefly depends on this coagulum of lymph; but while it is forming within, the extremity of the artery is further secured by a gradual contraction which it undergoes,

and by an effusion of lymph between its tunics, and into the cellular membrane 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. When the wound in the integuments is not healed by the first intention, coagulating lymph, which is soon effused, not only attaches the artery firmly to the subjacent and lateral parts, but also gives it a new covering, and completely excludes it from the external wound, which then goes on to fill up and heal in the usual manner. The circumstances now described are observed also in the inferior portion of the artery, or that which is supplied with blood by anastomosis; with this difference only, that its orifice is generally more contracted, and the external coagulum is much smaller than the one which adheres to the mouth of the superior portion of the artery, or that from which the blood flows in its direct course from the heart.

"From this view of the subject, we can no longer consider the suppression of hemorrhage as a simple or mere mechanical effect, but as a process performed by the concurrent and successive operations of many causes: these may be briefly stated to consist in the retraction and contraction of the artery; the formation of a coagulum 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."

I must observe, in regard to the observations which follow, that they have been deduced from others made on man, suffering from different states of injury, which the opportunities offered to me during the Peninsular war allowed me to make on an extensive scale. Some points have been corroborated by experiments made on animals; and I shall here acknowledge my obligations to Mr. Sewell, of the Royal Veterinary College, and to Mr. F. Thomson, who undertook several of them, and gave themselves much trouble to ascertain the objects I had in view.

In the different theories I have noticed, and especially in that of Dr. Jones, it does not appear that the gentlemen who proposed or maintained them have ever conceived that there was a difference in the means employed by nature, according to the size of the artery injured or divided; that the difference of structure between an artery, such as the carotid or the inguinal, and the tibial or the radial, could cause any deviation from the process they described as taking place, and as they presumed in one invariable manner in all arteries. I shall venture however to say, that on the size and variation of structure of the artery, the process employed by nature essentially depends; that it is not the same in large as in small arteries; and that it is not even quite the same in the upper and lower ends of the same artery.

An artery of moderate dimensions, such as the tibial or brachial, and particularly all below these in size, are in general capable by their own intrinsic powers of arresting the passage of the blood through them without any assistance from art, or from the surrounding

parts in which they are situated. This overthrows at once the whole theory which relates to the sheath of the vessel and its offices, and in a great measure to the importance derived from the formation of an external coagulum.

The fear of hemorrhage is so great, and pervades the minds of all men to such an extent, that few surgeons, and fewer patients, can calmly view its continuance, and each party seems alike desirous of suppressing it. The patient, however courageous he may be, however firm in mind, and capable of devoting himself by a sudden determined effort to the chance of a premature death, suffers an uncontrollable alarm at seeing and feeling as it were the ebbing away of life in the continuous flow of blood. Some indeed there are, who, preparing and collecting themselves for the last moments of expiring nature, either await its approach with a calmness that is rarely experienced but by those who are conscious of the purity of the time that has passed, or who appear to be alike unconscious of it or of what is to come hereafter. If hope is not extinct, and art can have the semblance of giving assistance, it is usually resorted to; so that the means employed by nature are frequently interrupted, and the process can scarcely be considered as unaided by art. It is only then when nature has not been interfered with, and the patient has not died from bleeding continued to the last moment, but has on the contrary lived some time after the hemorrhage has ceased, that the process by which it is accomplished can be fairly investigated. It does appear to me to be an odd way of ascertaining the method employed by nature to sup-

press hemorrhage, to bleed an animal until it dies, and then to reason upon the fact, of how the bleeding was suppressed, when it never was suppressed, or at all events by death alone.

In my work on Gunshot Wounds, I have related the case of a soldier, who had his arm carried away by the bursting of a shell at the siege of Ciudad Rodrigo, and who was brought to me shortly afterwards. The axillary artery becoming brachial was torn across, and hung down lower than the other divided parts, and pulsated up to the very extremity. Pressed and squeezed in every way between my fingers in order to make it bleed, it still resisted every attempt, although apparently by the narrowest possible barrier, which appeared to be at the end of the artery, and formed by its contraction. The canal was marked by a small red point, to which a very slight and thin layer of coagulum adhered, the removal of which had no influence on the resistance offered by the end of the artery to the passage of blood through it. In another case of a similar character, I cut off the end of the artery at less than an eighth of an inch from the extremity, when it bled with its usual vigour. In both, the vessel for that distance was contracted, so as to leave little or no canal at its orifice, and what there was, was filled by a pin-shaped coagulum.

During the action of Salamanca, a soldier was brought to me, whose leg had been nearly carried away by a cannon shot a short time before. On examining the wound, I found the posterior tibial artery pulsating to its extremity in a similar manner. As he had lost a considerable quantity of blood, and was much dis-

coura ged, I did not try to make it bleed, but amputated the leg forthwith. I have had many opportunities of seeing the same thing, and therefore I assert, that it is by no means of unfrequent occurrence in injuries of this nature.

In many cases of amputation at the wrist and forearm, in which I wished the patient to lose a certain quantity of blood, I have allowed either the radial or ulnar artery to bleed until it ceased. At first, the jet appears interrupted, then the stream becomes continuous, although projected further at each systole of the heart. As the orifice contracts, the flow of blood becomes more equal, it is thrown to a less distance, the size of the stream is smaller, and it goes on diminishing until it only oozes out, and then soon ceases; the extremity of the vessel being covered by a layer of coagulum of greater or less thickness. The experiment may be made every day on the temporal artery, with this addition, that as the stream diminishes let a fillip be given with the nail to the extremity of the vessel, when the jet will become a little larger; and this may be done several times, until at last it fails to have any effect, and the hemorrhage ceases. In none of these instances could the retraction of the artery be fairly estimated, although it appears from analogy, and from what is seen to occur in other cases, that a certain degree of it must have taken place. In similar cases, in which I have been able to make an examination either after death or amputation, the contraction of the vessel was evident, as well as the formation of a very slight external coagulum, extending into the canal of the artery. The sheath of the artery could do nothing,

because there was none, neither did the internal coagulum, which at this period strictly speaking does not exist. In small vessels, such as the radial or ulnar arteries, I do not believe any thing depends on the diminished power of the circulation; but when the axillary or femoral arteries are divided, the shock of the injury, and the loss of blood, powerfully contribute to the suppression of hemorrhage.

Having thus established the fact by observation and experiment on man, that arteries in the extremities of the second order in regard to size will cease to bleed, through their own efforts, unaided by the assistance of the surrounding parts, I must endeavour to prevent any misconception on the subject. I by no means intend to imply, that they cannot nor ever do receive any from them; for I am aware that in a great variety of instances, when the artery is divided in situ, great assistance is given by the surrounding parts, after the retraction of the artery, and from other causes.

The power and influence of the heart over the circulation through the arteries has been greatly overrated; and although it may appear strange on the first view of the subject, I have no hesitation in saying that the fact is exactly the reverse of that which is usually stated, and the sooner surgeons undeceive themselves the better. The heart exerts a comparatively trifling degree of influence over the circulation, a fact which may be easily proved by any one disposed to take the trouble of doing it. If the axillary artery be laid bare, previously to an operation for amputation at the shoulder, and the surgeon take it between his fore finger and thumb, he will find

that almost the slightest possible pressure will be sufficient to stop the current of blood through it. Retaining the same degree of pressure on the vessel, he may cut it across below his finger and thumb, and not one drop of blood will flow. Further, let the artery be fairly divided by the last incision, which separates the arm from the body, without any pressure being made upon it, and the result will be, that it will propel its blood with a force more apparent than real. All that is required to suppress this torrent, is to place the end of the fore finger directly against the orifice of the artery, and with the least possible degree of pressure consistent with keeping it steadily in one position, the hemorrhage will be suppressed; and what is more important is, that if the orifice of the artery, from a natural curve in the vessel, or from accidental causes, happens at the same time to retract and turn a little to one side, so as to be placed in close contact with a solid piece of muscle, the very support of contact will be sufficient to prevent its bleeding. These are facts, the two first of which I have placed beyond a doubt twenty times in my life. In 1816, I amputated twice at the shoulder joint in the York Hospital. In neither case did I allow the slightest compression to be made on the subclavian or axillary arteries. On the division of the artery, I first took hold of the divided end between my finger and thumb; then letting it go, I placed the point of my fore finger lightly on the very orifice of the vessel, and stopped the bleeding. In one case, in which I wished a certain loss of blood to take place, I did this twice before nearly a hundred spectators, no one of

whom afterwards doubted the fact. So confident am I on this point, that I care not in this operation whether a person be ready or not to compress the artery, satisfied that it is always within my own power to prevent any hemorrhage of importance.

In amputation of the hip joint, the femoral and profunda arteries are usually divided just below the origin of the latter: both bleed furiously if disregarded; but the slightest compression between the finger and thumb stops both at once. They never have given me the slightest concern in these operations, or others of a similar nature. I have been taught, by the experience of nearly all the battles of the Peninsular war, to hold all arteries that can be taken between the finger and thumb in great contempt, and I teach it accordingly, maintaining it by precept and example, both publicly and privately, on every occasion. It is quite impossible for a man to be a good surgeon, to do his patient justice in great and difficult operations attended by hemorrhage, unless he has this feeling, unless his mind is fully satisfied of the truth of these observations. Whilst his attention is called to more important circumstances, to which the whole of it should be directed, it is perhaps absorbed by the dread of bleeding, by the idle fear that he will not be able to compress the artery, that he may have a dozen vessels bleeding at once, that his patient will die on the table before him. Once fairly in dismay, and the patient is really in danger; but endowed with that confidence, which is only to be acquired through precept and example supported by experience, he surveys this scene with

the most perfect calmness, and taking the great artery between the finger and thumb of one hand, he places the points of all the other fingers, of both if necessary, on the next large vessels; or he presses the flaps or sides of the wound together until his other hand is at liberty, in consequence of a ligature having been passed around the principal artery. That it is a scene sufficient to try the presence of mind of any man, I admit; but he is not a surgeon who is not equal to it, who does not delight in the recollection of it when his patient is in safety, and his recovery assured. I have seen many persons die on the table under great operations: I never lost one myself from hemorrhage, except in one instance where a tourniquet was applied.

When a large artery is fairly exposed and divided, a very slight degree of pressure, perpendicular to its orifice, is sufficient to suppress all hemorrhage from it; an equally moderate pressure on the sides of the artery will prevent the passage of any blood through it. It is very different when an artery is only half cut through, and in a situation where the pressure cannot be fairly and equally although slightly made. It is then borne off from the part by a variety of causes, and the hemorrhage continues in spite of all attempts to suppress it. It is I presume from the consideration of such cases, and with a recollection of his own dismay and that of his assistants, that the surgeon has been led to suppose, that pressure will not stop the current of blood through a large artery; and, like Falstaff, he has magnified his dangers until he actually believed them to have occurred.

When the femoral artery is cut across in the *upper*

part of the thigh, whether it be done by a cannon shot, or a musket ball, or a knife, the patient does not always bleed to death, although he is frequently lost in consequence of the injury. He is less likely to die if the artery be divided in the middle or lower half of the thigh, but in both cases it is very probable that the hemorrhage will cease of itself; and if it recurs, it will be more likely to take place from the lower than the upper part of the artery, on account of the different process adopted by nature in these cases.

At the battle of Toulouse, I was the principal medical officer on the field of battle, and the superintendance of the wounded devolved on me, both at the moment and afterwards, until evacuated on Bordeaux. The injuries of arteries were made an object of primary importance, and great attention was paid to them by every surgeon in charge. The left of the British army had to march past the French batteries to turn their right, and in doing this, one large shot struck an officer and the two men immediately behind him, and nearly tore off the thigh of each. The officer's thigh was struck, and the artery divided about three inches below Poupart's ligament. I saw him about a quarter of an hour afterwards, in consequence of his surgeon saying it was a case for amputation at the hip joint. He was however dying, the pulse being feeble, the countenance ghastly, bedewed with a cold sweat, and with every indication of approaching dissolution. The house being at an advanced point, and close to one of the French batteries, the fire of round shot, shell, and musketry was so severe upon and around it, as to induce me to remain until the battery

should be taken by the troops then advancing on our flank. It was at this time I assisted Dr. Hume in the amputation of the thigh of a poor fellow who was suffering dreadfully, and whose case I have noticed page 241 of my work on Gun-shot Wounds. As the thigh bone was sawn through, a large cannon shot fell out of the amputated part of the thigh: the man sunk back into the arms of the assistant dead, and a cannon shot rolling up the garden walk, drove us from the table. On returning to the officer, I found he had just expired; and desirous of seeing by what means the hemorrhage had been suppressed, I cut down upon the artery, took it carefully out, and found that its divided end was irregularly torn; a slight contraction had taken place just above, but not sufficient to have been of the slightest service in suppressing the bleeding, which was in fact prevented by an external coagulum which filled up the ragged end of the artery, and was slightly compressed at its inner end, by the contraction which kept it in its place. The rest of the coagulum filled the hollow in the sheath which the retraction of the artery had occasioned. In this case, so unlike those I have hitherto noticed, the first natural cause giving rise to the suppression of the bleeding was the diminution of the power of the circulation; the second the formation of a coagulum, formed in the hollow of the sheath left by the retraction of the artery. Contraction had done nothing. The two men had been taken to an out-house a quarter of a mile off, and their thighs were amputated by staff-surgeon Lindsey next morning.

At the battle of Salamanca, I had the opportunity of examining the thigh of a French soldier, whose fe-

moral artery had been divided in a similar manner by a cannon shot. He lived until the next morning, when I saw him, no operation whatever having been attempted, nor a tourniquet applied. He died exhausted, but not from hemorrhage, which, when once it had stopped, did not return. The artery showed precisely a similar state as the preceding one, with this slight difference, that the orifice was a little more contracted, the external coagulum was less in size and projecting like a mamillary process.

In other instances of a similar nature in which I have examined the extremities of arteries, the appearances have more or less resembled the above; unless where the persons had died immediately, when the torn extremities have been quite open, and with very little or even no surrounding coagulum.

The great difficulty of ascertaining the several subsequent stages occurs from the circumstance, that the patients either die very shortly after the injury, or amputation is performed. They can only then be estimated from cases in which the artery is divided by smaller projectiles, or in which the artery has been wounded lower down in the thigh. I have had many cases of injury of the femoral artery under my care. In some instances it has been completely divided, in others it has only been injured. When the artery has been completely cut across, in the *middle or lower part* of the thigh, the patient has either died without assistance, or the hemorrhage has ceased spontaneously. I have not met with an instance in which it has been necessary to tie the femoral artery after it had been divided, and the hemorrhage had ceased for

the space of twelve hours, the efforts of nature being efficient to prevent its return; but I have had several opportunities of examining these arteries, in consequence of the patient's having died of gangrene of the extremity, or of hemorrhage from the lower end of the artery requiring amputation. In the 4th vol. of the Medical and Physical Journal, several cases which occurred to me at the battles of Albuhera and the assault on Badajos were published, bearing on this point.

Private J. Barnes, 29th regiment, on the 16th of May, at the battle of Albuhera, received a musket ball in the right thigh, 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 removed to Valverde, nine miles on a bad road, and on men's shoulders, in a blanket converted into a bearer. He was considered as one of the slighter 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 3d of June, eighteen days after the accident, the man was placed on a bullock car, to be removed with the rest of the wounded to Elvas; the mortification of the foot having ceased to increase, and a line of separation having been drawn. Shortly after the cars moved, I was informed that 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 it might be examined 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 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 this part I conceive that the hemorrhage came. The divided ends 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 is closed in the same manner. The lower or popliteal portion of the artery is very peculiar: the substance drawn across appears 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 even when the sides of the artery are 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. This case shows very distinctly the means adopted by nature for the suppression of hemorrhage from either end of a divided artery.

Another case, under similar circumstances a to the nature of the wound and mortification of the foot, occurred to me at the same time, save that no hemorrhage took place on the journey to Elvas, where the man died three days after of mortification of the leg. He did not remain under my direction at Elvas, so that I was not aware of his decease until after his burial, which took place in a few hours, as is usual in warm climates. I have little doubt, in this instance, that the artery was divided, and that nature had closed the open vessel in a manner similar to that above described.

Serjeant Baptiste Pontheit, of the French 64th regiment, was wounded by a musket ball, on the 16th of May, on the upper and fore part of the thigh, which passed out behind, in the direction of the femoral artery. He lost no great quantity of blood at the time, to the best of his recollection, and the wound went on well until the 26th, ten days after the battle, when one morning early he felt something give way in his thigh, and found himself bleeding from the wound, which however soon ceased on pressing his hand upon it. In the afternoon, on again moving, he lost about half a pint of florid blood, which induced the gentleman, who was called upon, to place a field tourniquet on the limb, and inform me of the circumstance. When at leisure

(in the course of two hours) I removed the tourniquet, and as no hemorrhage occurred, and there was no swelling in the vicinity of the wound, I replaced the dressing with a precautionary screw tourniquet, explaining to him its use, and the probable nature of his wound, together with the operation requisite to be performed in case of further bleeding.

I should before have mentioned that he was not a strong man, and was exceedingly anxious about his situation, and very restless: on turning at night he lost a little more blood, which ceased by his tightening the tourniquet, which was shortly after loosened. In the morning every thing being removed, there appeared some swelling about the wound, the opening of which was filled up by a coagulum: gentle pressure being made, it readily turned out, and was followed by a stream of arterial blood, leaving little doubt of the femoral artery being wounded. Compression being made upon it as it passes over the pelvis, I made an incision of three inches and a half in length, taking the wound as a central point, and exposed the femoral artery and vein: both were wounded, the former being half destroyed in its circumference, surrounded with coagulated blood, and appearing as if it had sloughed from being touched by the ball, the course of which was directly past it, and I conceive would have carried it away, if it were not for the elasticity of the artery allowing it to recede, and the cellular membrane in its vicinity more readily yielding. A ligature placed above, and another below the wound, secured both artery and vein; the incised wound was brought together by adhesive plaister, and the limb, as to the fore part of the thigh, placed in a relaxed position. The

operation was of short duration; he lost little or no blood, but the circulation was very languid, and the man exceedingly low. The warmth of the leg and foot was soon below the standard of the other; warm flannels were applied, and some brandy and water was given to him. In the evening the heat was more natural, and the man returned thanks for the humanity and kindness shown to him, congratulating himself and me upon the success of an operation which he had supposed to be infinitely more severe. The next morning he ate a tolerable breakfast, but felt a pricking sensation in the calf of the leg, which was as warm to the hand as the other, but the foot was cold. Second day, the swelling of the limb, its appearance, and discoloration on the under part, indicated approaching mortification, which on the 3d was evident, and on the 4th at mid-day he died, the limb up to the wound being nearly all in a gangrenous state. No adhesion had taken place in the wound, or in the artery, which showed the inner coat cut, the ligatures being firm, and no coagulum behind them. In this case, nature appeared from the first quite unequal to carry on any of the necessary operations; which may have arisen from the very debilitated state of the patient, as well as the double obstruction to the circulation. He did not lose in all more than a pint and a half of blood.

Captain St. Pol, of the 7th or Royal Fusiliers, whilst in the ditch at the foot of the breach at Badajos, was wounded in the ham from behind; he fell instantly, and lost as he thinks a considerable quantity of blood; he was on recovering raised from the ground, and

walked a few paces prior to his being carried to his tent, where I saw him in the afternoon of the next day, the 7th. The leg was gently bent, and turned outwards, and had ceased to bleed before his arrival in camp. A substance could be felt on the inner side of the patella, which by the sensation communicated to the finger on moving it appeared to be the ball; it was extracted by a valvular incision, after the manner recommended for the removal of cartilaginous substances found in joints. An artery was accidentally divided, and some dark-coloured blood also issued from the cavity; the ball was lying loose and unconnected; the finger on being passed in discovered no splinters of bone; the knee was swelled; and the entrance of the ball, which was a small one, would not admit the finger. His having walked some distance on the leg, and the absence of any splinters between the articulating extremities of the bones, induced Dr. Armstrong the surgeon and myself to think that the ball had entered with little injury to the bone; and after stating to the patient the little hope we had of ultimately saving the limb, independently of the great danger to which he was exposed, compared to the certainty of the operation of amputation at the moment, we consented to his retaining the limb for the present, thinking he would at least get through the inflammatory stage, when the operation could be performed satisfactorily to himself, although under more unfavourable circumstances. Seventeen leeches were applied immediately to the knee, and a cathartic given; the appearance of the leg and foot was natural; no diminution of heat, sensation of pain, or numbness, were

felt by the patient, or any thing observed by the surgeons. The next day he was removed into Badajos on a litter, the heat of the tents being insupportable.

On the morning of the 9th, I saw him early, and the want of circulation in the foot was evident from its having lost its natural colour and warmth; the knee was swelled, but not painful; and it was obvious to me, that the artery had been divided by the ball. The marbled appearance and yellow colour soon indicated the loss of the leg above the calf; vesications formed on the foot, already of a green colour.

On the 12th, the extent of the gangrene was defined, on the back of the knee up to the original wound at its lower edge, gradually receding as it advanced to the fore part of the leg, which for three inches below the knee was apparently sound; the uneasiness of the knee being moderate, the bites of the leeches and the incised wound looking perfectly healthy, although the latter had not united.

On the 16th, the separation of the dead from the living parts having taken place behind, and being well marked and commencing on the fore part, it was agreed in consultation to amputate the limb, which was done about the middle of the thigh. Sixteen vessels were tied, and as little blood as possible was lost. The parts were gently brought together, without much hope of union.

On the 18th, there being some swelling of the stump, the strips of plaister already useless were removed, one remaining as a support to the vessels.

20th. Half the ligatures came away at once, they having gradually formed into two parcels; the stump

was quite open, the bone well covered, and good granulations appearing, with a great discharge of well formed matter.

On the 22d, I did not see him, but was informed that the want of strength to carry on the necessary actions became apparent.

On the 24th, he died.

On dissecting the amputated limb, the sciatic nerve was found untouched, the ball having passed on the inside; the popliteal vein was also entire, having a small tumour adhering to its under part between it and the artery, the divided end of which I observed closed by a yellowish green firm substance, readily distinguishing it from the surrounding parts. On clearing the whole out from the bone, and making a small circular opening into the tumour, which was elastic and covered with brown fibrous layers, it showed itself to be an aneurismal sac, smooth on the inside, containing florid arterial blood, and some little coagula. The cavity of the sac is not perfectly regular, being nearly divided on one side by a process running into it. The artery, on being carefully slit up to the closed end, appeared to have been injured above the part divided by the ball, and to communicate with the sac by a small fissure or rupture, at the place where the piece of wood is inserted to keep the vessel open. The end of the artery is nearly slit up, so as to show the very little thickness of the closing substance, and the great original contraction of the diameter of the vessel. There was no internal coagulum, neither was there any laid over the external part of the artery; between it and the bone there was a coagulum

lying of the size of a small phial cork. Displeased with myself for having listened to the petition of hope, which I knew even under more favourable circumstances would be futile, I felt some satisfaction on viewing the diseased parts, which showed that process of nature completed, which in the former case had only been begun, although a longer period of time had elapsed.

We were inclined to suppose that the aneurismal sac existed prior to and independent of the gun-shot wound, considering that a sac of that nature could not be formed in ten days. Captain St. Pol did not remember any injury to have happened to, or any painful sensation to have existed in the knee before the accident; but Dr. Armstrong, who was in habits of intimacy with him, recollects his having once or twice mentioned some uneasiness in it, but in so casual a manner as not to have caused further inquiry. The other end of the artery I could not find from the state of the parts.

Private P. Turnbull, of the grenadiers of the 74th regiment, of good stature, was wounded on the 10th of April, 1814, at Toulouse, by a musket ball passing from the inside to the outside of the thigh: he says it bled considerably at first, but soon ceased: the wound was not painful, and he thinks he observed the leg and foot to be colder than the rest of his body for the first two or three days, but did not much attend to it, further than conceiving the numbness, coldness, and impeded power of motion, as natural to the wound.

On the 18th of April, the gentleman in charge of this patient pointed him out to me as an extraordinary case of gangrene coming on without any, as he sup-

posed, sufficient cause; the wound on the outside of the thigh, or the exit of the ball, was nearly healed, and that on the inside very simple, without inflammation or tumefaction, and with merely a little hardness to be felt on pressure. The pulsation of the artery could be distinctly felt to the edge of the wound, but not below it; the leg was warm, the gangrene confined to the toes; being a spare man, the artery of the other thigh could be distinctly traced through the tendon of the triceps. As he was at a small hospital, about two miles from town, on the field of battle, I did not see him until the 20th, and again on the 23d, when, although the gangrenous portion included all the toes, it had the appearance of having ceased. On the 26th, I was annoyed to find it had suddenly on the 25th began to extend, was at mid-day on the 26th above the ankle, with considerable swelling up to the knee. At night the man died; and the next morning at six o'clock I removed the femoral artery from Poupart's ligament to its passage through the triceps, which part was affected by the mortification.

The ball had passed between the artery and vein, in the spot where the vein is nearly situated behind it, and adherent only by cellular membrane, through which the ball made its passage, the coats of the vein being little injured, and those of the artery not destroyed in substance, although wounded; it is at this spot much contracted in size, and filled above and below by coagula, which prevented the transmission of blood. The artery is impervious. The vein above and below the wound is filled by a coagulum, and impassable. I have the preparation, and it is perhaps the

hosonly one in existence to prove the elasticity which vessels possess, and their capability of avoiding to a certain extent an injury about to be inflicted upon them.

After the battle of Salamanca, I was requested to see a soldier of the fifth division, who had received a shot in the thigh nearly in a similar place, which had been followed by gangrene of the toes, not extending to the tarsus. The correctness of my opinions not being at that time acknowledged by my friend Dr. Emery, who showed the case to me from knowing my desire on the subject, he did not amputate when the mortification began suddenly to spread, and this man also died on the day after that occurrence.

A Portuguese, at the same battle, suffered from a wound of a similar nature, but rather lower in the thigh. The mortification which followed was confined however to the great toe only, and great hopes were entertained that it would not spread, when a hemorrhage unexpectedly took place from the wound, and the artery was tied above it. The hemorrhage returned and was suppressed, but the patient sunk and died. On examination it was found that an error had been committed (I have seen it since done in London); and that a large branch from the femoral artery running parallel with it had been tied instead of the wounded artery itself, which had yielded by ulceration, not having been cut in the first instance.

Don Bernardino Garcia Alvarez, captain of the regiment of Laredo, thirty years of age, was wounded at the battle of Toulouse by a musket ball, which passed through the thigh a little above its middle. The

wound was not considered a dangerous one until the 30th, twenty days after the injury, when a considerable bleeding took place; and as the vessel from which it came seemed to be very deeply seated, the Spanish surgeon in charge tied the femoral artery. I saw the gentleman in consequence of this having been done. The hemorrhage was suppressed by the operation, and the limb soon recovered its natural temperature, but gangrene made its appearance on the great toe on the third day afterwards. It did not seem to increase, but the limb swelled, as if nature was endeavouring to set up sufficient action to maintain its life, and this continued until the tenth day after the operation, when he died completely exhausted. On the dissection of the limb, the femoral artery was found to be perfectly sound in every part below where the ligature had been applied. The vessel which bled could not be discovered; but it was clearly a branch from the profunda, and not the femoral itself. In this case the ligature of the femoral artery destroyed the patient. The practice should have been similar to that pursued in the case of Wilson, related page 317; or, if an operation became necessary, the injured or gunshot wound should have been largely dilated, at both orifices if necessary, until the wounded vessel was discovered, which was in all probability not completely divided by the ulcerative or sloughing process which had taken place, and the division of it would have suppressed the bleeding.

Cases of wounded arteries were not numerous after the battle of Waterloo, as far as regards the hospitals in Brussels. I shall hereafter notice some of them. One occurred in a French prisoner in the Gend'armerie

hospital, and for which the femoral artery was tied: it proved fatal from gangrene of the foot and leg.

I have seen three cases of mortification following wounds of the femoral and popliteal arteries in London. One occurred in a private patient, and two were in the Westminster hospital. In the first, the injury was received in the upper part of the thigh at night, from the shaft of a van, the wound being three inches long and parallel to Poupart's ligament. I did not see the wound, but the next morning at twelve o'clock the nature of the case was obvious to me, although to no one else. The tallowy white and mottled appearance of the foot and lower part of the leg, clearly indicated the loss of life from a deficient supply of blood. These symptoms gradually became more marked, until the occurrence of mortification admitted of no dispute. On the eighteenth day after the accident blood flowed from the wound in considerable quantity, and of a dark or venous colour. This, after a troublesome operation, was only arrested by a ligature, which included the artery and vein at the lower end of the sloughing wound. The patient died exhausted; and on examination the femoral artery was found distended with dark-coloured blood below the ligature. If this man's thigh had been amputated the morning after the accident, he would have had a chance of life. The dark colour of the blood, which flowed at the hemorrhage which preceded his death, was the natural result of an impeded and obstructed capillary circulation.

The second and third cases, which occurred at the Westminster Hospital, were both lost from the extension of mortification. The popliteal arteries had been

injured, and the same tallowy mottled appearance was visible in the leg in each case as in the former instance on the day after the accident. Nothing was done, and they both died, waiting for the mortification to stop by the establishment of a line of separation, which under similar circumstances rarely or never fairly takes place.

It is unnecessary to multiply cases showing the occurrence of mortification after an injury of the femoral artery. Those I have already noticed place the fact beyond all doubt; and although mortification does not occur in all such cases, it is always to be dreaded.

An artery of the size of the femoral at the *middle* or *lower* part of the thigh, retracts on being divided within its sheath; this retraction is also accompanied by a contraction of the orifice or extremity, which gradually assumes the shape of a Florence oil flask, or French claret bottle, in a similar manner to the contraction of the axillary artery, described page 224. I have not met with an instance so perfectly clear and decided of the femoral artery hanging out of a wound as in this case of the axillary artery, so as to demonstrate that the whole process is carried on in a similar manner. I have however seen the femoral artery at the lower part of a thigh, which had been struck by a cannon ball, so little supported by coagulum, and yet so much closed, as to lead to the belief, that in some instances the extremity of it may be closed by similar means, a conclusion which analogy would lead us to, if observation were wanting. In all successful cases, the retraction of the artery leaves a space occupied by a coagulum, which also in an artery

of this size fills up the contracting opening, which is in a circular direction, just within the ragged edges, which when they exist do not themselves contract, because the continuity of fibre is wanting. The continued contraction of the artery expels the external coagulum, and this operation is assisted by the lymph effused from the cut edges and from the coats of the vessel; so that in a few days the whole of the coagulum is removed with the purulent discharge from the part; and the place it would occupy, the orifice of the artery, and the surrounding parts for at least an inch in extent, are filled up and covered by a yellowish green-coloured matter, very distinct in appearance from the neighbouring parts. On the examination of a wound after death or amputation, in which it was known that a great artery had been divided, I have always from this appearance pointed out the situation of the extremity of the artery.

The contraction of the divided end of the artery is confined in the first instance to its very extremity, so that the barrier opposing the flow of blood is formed by this part alone, as I proved by cutting it off in the case mentioned, page 224. This contraction goes on however increasing for the space of an inch, and the inside of this contracted inch of the vessel is filled up with an internal coagulum, which takes the shape of and adheres to the inside of the artery, rarely extending as far as a collateral branch, or under almost any circumstances beyond a couple of inches. Towards the extremity of the artery it adheres firmly, so as to form a real substantial obstacle to the flow of blood through it. The very orifice of the artery on the

outside of this is covered by the yellowish green-colou red matter or lymph, which ultimately becomes organized. These processes are continued long after the wound is healed. The artery generally goes on diminishing and contracting up to its first large branch, so that of four or five inches, two or three will be impervious, the remaining part very much contracted, although perhaps still permeable by a probe. The accompanying nerve, where there is one, has just done the reverse, the cut extremity having become enlarged or bulbous, and gradually diminishing as it is traced upwards, until it becomes of its proper size.

It is a very curious and interesting fact, that the lower end of a divided artery is more prone to secondary hemorrhage than the upper; so much so indeed, that when it occurs after having been arrested for a period of four hours, it takes place in all probability from the lower end. This may always be known from the darker colour of the blood, and from its flowing out in a continuous stream, in the same manner as water rises from a spring, and not with any arterial impulse. The surgeon has no right to believe that the blood comes from the upper extremity of the artery, unless it is of a florid, scarlet, arterial colour, when it will usually rush out with force, if not with the undisguised arterial impetus. This cannot be an accidental circumstance, it has happened much too often to be attributed to such a cause, and it has appeared to me to arise from a difference in the process adopted by nature in one end of the artery to that in the other. It is a point to which I paid particular attention during the whole war, and which I have since made the subject of ex-

periment. I cannot be mistaken as to the fact, although I may err in the explanation.

I suspected at first that the lower end of an artery did not possess the same power of retracting and contracting as the upper part; but further observation satisfied me, that although I might be correct in these points, still that the contracting power was very considerable, and in some cases sufficient to close or nearly close the lower end of the femoral artery, when divided in the common operation of amputation just above the knee. I still believe that the retraction or contraction may not be so complete as in the upper end of the vessel, and I am certain they are not so permanent. Other circumstances led me to suspect that the internal coagulum of blood was not so perfectly formed; and I have reason to believe, both from observation and experiment, that this is the case. When the artery is fairly cut across, the blood is not continued into the canal below, which is emptied in the first instance by the action of the capillary vessels. A small quantity flowing from the upper extremity may insinuate itself within the contracting lower orifice and remain within it, which I think I have seen occur in the experiments alluded to, and which were made for the purpose of ascertaining this fact. Where the collateral circulation is powerful or active, the blood soon regurgitates in the artery, particularly if the person be young; but the force of the regurgitation can be in no proportion to that of the propulsion at the other or upper end of the vessel, which nevertheless will remain closed, whilst the lower one opens after the lapse of a few days and bleeds. In middle aged and elderly persons, this

regurgitating blood may not reach the lower divided end of the artery for many hours or days, as I presume is sometimes the case where mortification takes place in the extremity from the injury, and then it is principally venous blood. Whether this can make a difference, or whether it is that the artery is then in a different state, I know not; but in all those cases I have had an opportunity of examining, in which hemorrhage had taken place from the lower end of the artery, the following appearances were observable.

The same kind of yellowish green matter marks and covers the situation of the lower extremity of the artery, as it does the upper; it is, however, thinner where it immediately covers the end of the artery, which in none of these cases was contracted in the conical manner I have described as occurring in the upper extremity of the vessel. On the introduction of a probe into the artery with the greatest gentleness from below, it made its appearance at a point on the yellow space, raising a thin portion of it as it protruded. On laying open the artery, the orifice seemed to have been once closed by this layer of fibrine or lymph, but without a degree of contraction corresponding to that observable in the upper end of the same artery; the layer still forming an obstacle, sufficient to cover and close three-fourths of the orifice, the blood having flowed through the remaining fourth.

These appearances seem to indicate a different process in nature to that adopted for the closure of the upper end of the vessel; and the frequency of their occurrence to demonstrate that the process is a

natural one. I have been led to conclude that the retraction and contraction of the lower end of a divided artery is neither so perfect nor so permanent as at the upper end; and that the internal coagulum is in many instances altogether wanting, or very defective in its formation; giving rise to a very different result from that which is observable in the upper divided end of the same vessel.

I was first led to make this observation from the examination of the limb in the case of Barnes, related page 233: subsequent observations confirmed the fact; and the following case, illustrative of several points which have been alluded to, was to me most satisfactory.

Serjeant William Lillie, of the 62d regiment, aged thirty-two, was wounded in the right thigh on the 10th of April, at the battle of Toulouse, by a musket ball, which passed through the rectus, cruræus, and triceps muscles, in an oblique direction downwards and inwards, close to the bone, describing a track of seven inches. The ball was extracted behind on the field. He said he had bled a good deal on the receipt of the injury, which he had stopped by binding his sash around the limb. The discharge from the wound was considerable: it appeared however to be going on extremely well until the 29th of the month, when, on making a sudden turn in bed, dark-coloured blood flowed from both orifices of the wound in considerable quantity. I had given an order, as the chief of the medical staff in Toulouse, that no operation should be performed on a wounded artery, without a report being sent to me, and an hour at least

granted for a reply, unless the case were of too urgent a nature to admit of it. This appeared to be the case in this instance, and before I arrived Mr. Dease had performed the operation for aneurism at the lower part of the upper third of the thigh. I could only express my regret that it had been done, and point out the probability of the recurrence of the hemorrhage, which took place on the 7th of May. The limb was amputated, and the patient died. On examination of the artery, it was found to have been divided exactly where it passes between the tendinous expansion of the triceps and the bone; the upper portion of the artery divided by the shot was found closed: a probe introduced into it from above, would not come out at the face of the wound, although the impulse given to the part on moving it was observable in the middle of a large yellowish green spot, which I had previously declared to be the situation of the extremity of the artery. The vessel at this part had contracted in the shape of a claret bottle, for about an inch, and an internal but small coagulum was observable in it for nearly the same extent. The lower end of the artery from which the hemorrhage had taken place was marked by a spot of a similar character; but on passing a probe upwards from the popliteal space, it came out at a very small hole in the extremity of the artery in the centre of the spot; the canal of the artery not being contracted and diminished, but only apparently closed by a layer of the yellowish green lymph laid over it, and adhering to its circumference.

A case occurred to me at Salamanca so similar

to this in every respect, save that the man died from hemorrhage in the night, that it is unnecessary to notice it further, the appearances on dissection being the same. From these and other opportunities which I have had of making similar observations, I am led to conclude that the fact is established, of a difference taking place in the manner by which nature closes the upper and the lower divided end of the same artery.

When an artery is merely cut or torn, but not completely divided, it is in the same state with regard to hemorrhage, as if it had given way by ulceration. It can neither retract nor contract, and will continue to bleed, unless pressure be accurately applied and maintained, until it destroys the patient. The practice to be pursued is to divide the vessel if it be a small one, such as the temporal artery, when it will be enabled to retract and contract, and the bleeding will soon cease. If an artery of larger dimensions be wounded, a ligature should be applied above and below the wound, and the vessel may or may not be divided between them, at the pleasure of the surgeon. At page 136, I have related the case of a young gentleman, whose femoral artery I treated in this manner. At the battle of Talavera, a man was brought to me during the action, who had lost a large quantity of blood from the arm, in which he had been wounded by a musket shot, and which was only stopped by tying a handkerchief tight over the wound. On examination, I found the shot had passed through on the under edge of the biceps, and out behind, injuring the brachial artery, which bled again profusely. I laid the artery bare, which was cut half across, placed a ligature above and

below the wound, and sent the man into the town. The necessity for this practice is so clear, and it is so well understood and explained throughout, that further illustration becomes useless.

Of the Methods of performing Operations on Wounded Arteries.

The manner of performing operations for aneurism is dependent on certain definite rules, according to the situation of the tumour, which admits of their being made with precision in every instance. There may be more than one mode of doing the same operation; yet however numerous they may be, they are all of them clear and distinct, and are laid down as such in every treatise on this subject. Surgeons have been contented to refer to them in writing on or noticing wounds of arteries, in consequence of the erroneous ideas which have been entertained on these points; and they have innocently concluded, that the same methods of operating, the same directions, the same mode of proceeding, would suit the injury as well as the disease. This error has arisen from not thoroughly understanding the subject, from not taking the clear and comprehensive views which extensive observation and experience can alone give,—the only points upon which I can have any claim to public attention, and which must be my apology for thus earnestly pressing the subject.

The brilliant theory of the cure of aneurism by the Hunterian method, and the more brilliant operations which followed it, seemed to have obliterated the

recollection of the ancient methods of proceeding in regard to wounded arteries; and it was not until repeated failures had convinced every one of the impropriety of applying the theory of the operation for aneurism to wounded arteries, that it was abandoned, and the old method was resorted to of tying both ends of the wounded artery. Upon this point I have long since claimed my share in the restoration of the proper method of proceeding. The principle was abandoned, but the *modus operandi* has been retained, as if the operation were for aneurism, and not for a wounded artery; and this I hope now to rectify.

In an operation for aneurism, the directions are all laid down with precision: a just proportion of the common integument is to be divided, and no more; then so much fascia of various kinds; then such a muscle is to be turned, dissected inwards or outwards as the case may be, or detached, but on no account is it to be divided; and the operation is to be finished by applying the ligature in the particular place which has been exposed by these proceedings. Nothing can be more proper in a case of aneurism; but the wound of an artery is an accidental occurrence, it does not happen always in the particular place which will suit these directions; nevertheless they are to be adapted to it in the best way that can be thought of, and the young surgeon is left to his discretion. The principal error in this method of proceeding, as adapted to wounded arteries, arises from a strange and unaccountable fear of cutting muscular fibres, which seems to pervade the minds of all the surgeons of the present day, who have treated on these subjects. A dread so

truly ludicrous, that it appears incomprehensible how it can possibly have continued until the present time. I shall suppose that a gentleman of rank and importance in the country is struck on the back part of the leg by a very sharp cutting instrument, which divides the muscular fibres of the gastrocnemius and soleus muscles in a longitudinal direction, cuts across the tendon of the plantaris, but does not injure either the fibular or posterior tibial artery or its nerve. I shall further suppose, that any one of the best anatomists and surgeons in London is sent for, and his opinion desired as to the result of the case: I venture to assert that he would say, his patient was a most fortunate man to have suffered so little injury from such a wound; for if the posterior tibial artery or nerve had been divided, he might have bled to death, or have been lamed for life; but that under existing circumstances, he hoped by position, quietude, compress, bandage, &c., that is, by a due application of the usual means, to be able to reunite the wounded parts; so that in all probability, unless some untoward circumstances took place, the gentleman would soon recover, and without any permanent defect or lameness. No man of knowledge could say otherwise. Let us now suppose that the same gentleman, having been cured of the accident according to the opinion of his surgeon, has the misfortune to be wounded by a pistol ball in a duel whilst standing sideways towards his opponent; so that the ball passes across the calf of the leg, close behind, but not injuring either bone, although dividing the fibular or posterior tibial artery, which bleeds in such a manner as to re-

quire the ligature: we will also suppose the same surgeon in attendance: what operation would he do, and how would he set about it? I will take the liberty of suggesting, that in a case of this kind, blood would flow from both wounds, and that a surgeon acquainted with his profession would first endeavour to ascertain which vessel was wounded. This he could only do by enlarging one or both openings, so as to enable him to introduce his fore finger into each, the point of which might from its sensibility detect the wound through the impetus of the flow of blood, if it happened to be placed on the cut part of the artery. In this manner he might possibly be enabled to judge with accuracy which of the vessels was wounded, although it might very readily happen that both were injured and both were bleeding. The minor disaster will answer our purpose, and one vessel only shall be wounded. Shall he with the Baron Dupuytren tie the femoral artery as for aneurism, or shall he, on the other hand, cut down and tie both ends of the artery. We will presume that he decides on the latter operation, and the following description of it is taken from the best English anatomical and surgical work on the arteries extant.

"This operation of tying the posterior tibial artery in the middle of the leg, will be found much more difficult than either of those described, as this vessel here lies at such a depth from the surface, and is covered by the gastrocnemius and internal head of the soleus, which in this situation is attached to the tibia. To expose the artery here then, the leg should be bent, the foot extended, and both placed on the outer side; make an incision about four inches in length along

the inner edge of the tibia, through the integuments and fascia (the internal saphena vein should be avoided), the edge of the gastrocnemius muscle will be exposed, this may be easily raised and drawn to the outer side; a director must then be insinuated beneath the head of the soleus, on which this muscle must be divided from its attachment to the tibia: the deep fascia of the leg is here very tense and strong, binding down the deep-seated muscles and the tibial nerve and vessels; this must be cautiously divided on the director passed beneath it. The foot should now be extended as much as possible, and the knee placed in the flexed position, to relax the superficial muscles on the back part of the leg; the artery may be now felt pulsating about an inch from the edge of the tibia; the veins are then to be separated from the artery with a blunt instrument, and the aneurism needle passed round the latter in a direction from without inwards, so as to avoid the posterior tibial nerve.

"On the dead subject this operation is not attended with much difficulty; in the living however the case is very different: the muscles are then rigid and unyielding, and when the fascia which covers them is divided, they leave their natural situation and become much elevated, so as to make the situation of the artery appear as a deep cavity, at the bottom of which the vessel is placed." Add to this that the artery is cut across, has retracted upwards and downwards, and that both ends may not bleed, although both require to be tied, and that he may have made a mistake, and finds that it was the other and more distant artery that is wounded, or that both are injured.

Let us proceed however with the simple case. The operator has cut his four inches, has turned up the edge of the gastrocnemius, and has insinuated his director under the head of the soleus, which he has also sliced away from the bone. The artery is still an inch inwards, bound down by a strong fascia; pulsating the book says, bleeding I say, all this time as fast as it can, or else a tourniquet has been applied, and the pulsation has been suspended. The fascia must be cut immediately over or by the side of the artery; it will not do to separate it from the bone and then to push it over; it cannot be done, and would not do if it could. The artery must then be allowed to bleed. The tourniquet must be unscrewed, and the wound is immediately filled with blood. Nothing can be done until this is sponged out, and to enable this to be done, the tourniquet must be screwed up, and then the surgeon is pretty much where he was before. We will suppose that he has succeeded in dividing the fascia, for an inch at least in extent, over the artery, without injuring it or any thing else. What is directed to be done next? Why certain evolutions are to be performed with the leg, as described above, and then the surgeon is to separate the two veins from the artery with a blunt instrument, and then he is to pass an aneurismal needle under the artery from without inwards, so as to avoid the nerve. Now all this is to be done in a hole, the bottom of which the operator can scarcely see, and if he could it would not signify, because it is on the side of the bottom of the hole he is to perform these different evolutions; on parts too, likely to be covered continually with blood; for al-

though the bleeding from the upper end of the artery may be suppressed by the tourniquet, that from the lower end in young persons may not; and at all events the unscrewing of the tourniquet will give rise to a most troublesome oozing, occupying a great deal of time, and giving rise to much pain. Lastly, when the operator comes to the fascia, he will find his first four inches will not give him room enough; if he succeeds in dividing it, and tries to find the artery, the deficiency of space will cause him to enlarge his first incision; and before he has completed his operation, the quantity of cutting, retracting, pulling, sponging, and bleeding, will make it to himself a most unsatisfactory operation. Of the patient's sufferings we will say nothing. If a bystander should inquire, why this most painful, difficult, bloody, tedious, and dangerous operation (dangerous from the chance of failure) is done? the answer would be, solely because it was not usual to make a longitudinal incision in the muscles of the calf of the leg; an incision which if made by accident would be pronounced to be one attended with little danger, and not likely to lead to any subsequent detriment. Let us compare the preceding operation with the following.

An incision is to be made six or seven inches in length, by successive and rapid incisions, through the integuments and muscles of the calf of the leg down to the fascia. The centre of the incision is to be on a line with the shot holes, or if they are diagonal to each other, between them; and it may be either directly in the middle of the calf, or a little to the side of, or directly over the artery supposed to be wounded: it

is not material which. The smoothness of the fascia points it out, and the loose cellular membrane connecting the divided muscles to it, allows of the edges of the long incision being easily separated, and to such a distance as to admit of the exposure of the great nerve, the arteries, and veins, in as distinct a manner as any other arteries, veins, and nerves, can be exposed in the human body. The tourniquet is now to be unscrewed, and the bleeding, if the wound did not bleed before, leads to the spot where the artery is injured. The knife may be applied perpendicularly to the fascia, and the artery laid bare for three or four inches in extent, by as common a piece of dissection as any ever practised, and nothing can interrupt the application of the ligature. The nerve and the fascia cease to be surgical bugbears, and the operation is as simple as any in surgery. No surgeon or anatomist will dispute this statement: he may however say, that the muscles have been divided, and that surgeons have not been in the habit of cutting through them by a fair incision in their length; that they have hitherto only done it by insinuating a director under the head of the soleus, and separating it from its attachment to the bone; as if the separation of a muscle from its bony attachment was not much more likely to lead to weakness and defect in the action of that muscle, than a mere interstitial incision in a longitudinal direction. There is no anatomist who will deny that it is so.

It is now necessary that I should go a step further, and show that a muscle is to be cut transversely to its course or fibres, whenever it may be desirable to do so, in order that a ligature may be placed on a

wounded artery beneath it; and also to prove that little or no inconvenience results from such a proceeding.

Lieutenant Colonel Wildman, now of the Carabineers, was wounded at the battle of Albuhera, by a sabre cut directly across the middle of the deltoid muscle, so as to divide it completely down to the bone of the arm. He was taken prisoner at the same moment, and the French surgeons dressed his wound by filling it with charpie, and then bound the arm down to the side. He made his escape in the night, and was brought to me on the second day after the accident. The first thing I did was to remove the dressings, raise the arm to a right angle with the body, by which alteration the edges of the wound might be brought into contact, and then try by a continuation of the position, and by compress and bandage, to keep the parts together, so that as little deficiency of substance might appear as possible. The wound did not unite under this treatment by the first intention, but it readily did so by granulation, and his recovery is so complete, that at this moment he is unconscious of any defect in strength or motion whatsoever.

At the battle of Salamanca, a French soldier received a sabre cut, vertically and directly across the fibres of the pectoralis muscle, at the inner side of the vessels; the lower and fore edge of the muscle was completely divided. The man had other wounds, but this one was never considered but as a simple one, and by proper compress and bandage, it united so as to leave merely a little weakness of no consequence.

A division of the fibres of the pectoral or of any other muscle, transversely to its course, is then

under proper treatment an injury of little consequence: indeed, if a patient were brought to a surgeon with such a wound in the neighbourhood of the axillary artery, the congratulation would be that the artery and nerves had escaped injury, and this would be accompanied by an assurance that the patient would soon be as well as ever. Yet if by accident he should receive an injury by a small sword or stiletto, which injured the artery through this same pectoral muscle, it would be at once declared highly improper to cut it across; and to avoid this trifling and as above shown unimportant operation, all sorts of difficulties would be incurred, all sorts of errors would be committed. The artery would be sought for in every direction but the right one, *viz*, by dividing the muscle transversely to its course, taking the hole or cut as the centre of the incision, if possible or necessary, and then looking down upon the artery surrounded by its accompanying veins and nerves, as if it were a common demonstrative dissection. Let us see what is said in the last book on this subject.

"The patient may be seated, with the shoulder of the affected side inclined backwards: an assistant should be placed behind the patient, with instructions to compress the subclavian artery in the event of hemorrhage: a semilunar incision is to be made about three inches long through the integuments, commencing about one inch from the sternal end of the clavicle, and extending towards the acromion process as far as the anterior edge of the deltoid muscle, avoiding the cephalic vein and thoracica-acromialis artery; the clavicular portion of the pectoral muscle is thus

exposed, and is to be divided in the same direction, and to the same extent, as the external wound; the flap thus formed is then to be everted, and some loose cellular membrane being detached, the superior edge of the lesser pectoral muscle will be exposed: in this stage of the operation, several branches of the thoracic arteries are in danger of being wounded. A director should then be insinuated beneath the strong fascia extending from the subclavian muscle to the coracoid process, and a portion of the fascia divided. Some loose cellular membrane and a few small blood vessels being detached with the blunt extremity of a director, the axillary vein will be exposed; this vessel should be pressed inwards towards the ribs, and the artery will be felt or seen pulsating; it must be carefully detached from the nerves for a short distance, and the aneurism needle passed under it, the needle being directed from the thoracic to the acromial side. In applying the ligature, it is to be recollected that one of the large nerves of the plexus inclines to the front of the artery, and having a pulsation communicated to it, might be mistaken for the artery itself.

"Even on the dead body, this operation is by no means easily performed; but on the living subject it must be attended with considerable difficulty, particularly in corpulent persons: the depth at which, in such individuals, the artery lies, together with its complicated relations, must render the application of a ligature to it peculiarly hazardous. It appears to me that few cases can occur in which the operation now described ought to be preferred to that of tying the subclavian artery external to the scaleni muscles; at the

same time it must be admitted, that an extensive wound passing through the pectoral muscle, may expose the axillary artery, so as to render the application of a ligature to it in this situation comparatively easy."

This description is critically and anatomically correct; no man in the United Empire could do the operation better than the author of the work from which I have extracted it; and yet the operation is so thoroughly dangerous and useless, and so contrary to true principles, that it ought never to be performed. It ought to be struck out of the catalogue of operations. I know it to be dangerous, because I am aware of two persons having died under it, before the ligature was applied, the axillary vein in both instances having been injured. In aneurism of the axillary artery, the operation should always be done above the clavicle; and in a case of wounded artery, at the spot in which the artery is wounded. Let us take an example from Mr. C. Bell's Commentary on John Bell's Surgery, vol. i, page 369.

"A girl had her arm torn off near the shoulder by machinery. There was no bleeding, nor could the trunk of the artery be seen. As the arm had been almost fairly amputated by the machine, it was unnecessary to do more than make the edges of the wound even, and bring them together. As the axillary artery had not been tied, the patient was carefully watched. In the course of a few days hemorrhage did come on, and the surgeon very properly tied the artery below the clavicle. The bleeding from the stump immediately stopped, and every thing went on well for

several days; the stump became clean, and was granulating, when a second violent hemorrhage took place from it. The surgeon did not reach the hospital until the patient had lost a considerable quantity of blood. He immediately tore open the stump, which was already partly united, and now he saw the blood issuing from the main artery. He secured it; but the patient sunk next day. On dissection, and by injecting the vessels, it was shown that the artery, where it had been tied below the clavicle, was obliterated, and that the blood had passed round by the supra-scapular branch of the inferior thyroid, from the portion of the subclavian artery above the ligature into the part below."

The surgeon in this case performed a very dangerous operation in a very admirable manner, and according to the principles he had been taught. Nevertheless it was done contrary to every principle of good surgery, and, as far as I can see, for no other reason than for the purpose of avoiding a few fibres of the pectoral muscle.

In the first place, an operation, confessedly a very dangerous one, was done, when it was in no way necessary, and which proved perfectly useless; a second requiring to be performed afterwards, of a very simple kind, and which was the one which ought to have been done at first; namely, searching for the bleeding end of the artery, and tying it. A life was here lost for want of a knowledge of principles, and it is necessary that the error be corrected, lest others commit the same mistake. It was the Hunterian operation for aneurism applied to a wounded artery, and it failed, not for want of

anatomical knowledge or dexterity, but from misapplication.

Mr. J. Bell has said that the circulation of blood through a large artery could not be suppressed; a statement which I disproved many years ago, and which can no longer be maintained. As a plain matter of fact, in regard to healthy or wounded arteries, it is looked upon as a surgical fiction, arising from the supposition that what took place once or twice in aneurism, must occur in every case. Mr. C. Bell, by avoiding the direct question and matter of fact once in dispute, *viz.* "whether the flow of blood through a great artery can be stopped by compression," has made a very good defence of his brother's opinions, and I would willingly pass it by from the kindness of the motive, if it were not contrary to the true interests of science and humanity. He says, page 366, "the fact is, as it is strongly expressed by my brother, the blood will flow notwithstanding the utmost compression of the thumb or knuckle on the inguinal artery; and this he is quite right in asserting, 'though as many devils as there are tiles in Bath were combined against him.'" He further says, "the truth of the matter is, that if the inguinal artery were squeezed with a vice, the vessels of the thigh would bleed notwithstanding;" a fact which nobody ever disputed, but which has nothing to do with the previous question. That the collateral circulation continues in the generality of cases is admitted, for what would become of the Hunterian operation for aneurism if it did not? and why is it that the operation is declared to be improper in cases of wounded arteries? solely because the collateral circulation brings

the blood into both the upper and lower ends of the divided artery, rendering it necessary to place a ligature on both extremities of it. It is on account of this taking place, that the operation on the axillary artery, which it is said was properly done just below the clavicle, appears to me to be contrary to the true principles of surgery, on Mr. Bell's own showing. As to the collateral circulation giving any trouble in amputation of the thigh to surgeons of experience, I am sorry to say that I cannot admit it to be the fact, because I have always found it to be otherwise.

When the axillary artery is divided, and compression made above the clavicle, it does not bleed by means of the collateral branches: because they are not capable of restoring the circulation so rapidly in so short a space. It is not carried on in the first instance by trunks, but by very small branches, as I have fully explained, page 135. That this is the fact is proved from the case which has led to this discussion: it is therein stated, that for an axillary artery *torn* near the shoulder, the artery was tied just below the clavicle, and it suppressed the hemorrhage, which it should not have done, if there had been any truth in Mr. Bell's doctrines. But let us inquire what really did take place: after several days, a second violent hemorrhage came on, that is after the collateral branches had re-established the circulation by trunks, and then the surgeon tied the artery at its bleeding end: there is therefore an error as to the powers and capabilities of the collateral circulation both in principle and in fact. Mr. J. Bell fell into an error in applying the doctrines of the collateral circulation in cases of aneurism to

cases of wounded arteries, in which the collateral circulation, as I have shown, is not in the same state; and the sooner the error is admitted the better it will be for the interests of humanity.

There is yet a point of a similar nature to discuss: it is the manner of securing the ulnar artery when wounded a little below its origin, and whilst covered by the pronator teres, and the superficial flexors of the fore arm, *viz.* the flexor carpi radialis, palmaris longus, and flexor digitorum sublimis. A most excellent writer on the arteries, and whose book as an anatomical work is invaluable, says, page 215, "In the superior third of the fore arm, the great depth at which this artery lies from the surface, and the number of muscles which cover it, render it impracticable to pass a ligature around it." A very simple question naturally presents itself, why is it impracticable? The answer is, it cannot be laid bare unless the muscles named above be divided; but to the question why this should not be done, it would be difficult to reply, unless it is honestly answered, there is no reason why it should not be done, unless it is that it has not been usual to do so.

I shall refer to a case in point. The surgeon says, "I was consulted in the following circumstances. A child having a sharp pointed knife in its hand, had wounded the nursery maid below the elbow, and close to the ulna. The ulnar artery was wounded near its origin from the brachial artery. It bled profusely, and the surgeon tied the main artery by the side of the tendon of the biceps muscle. This stopped the hemorrhage for a time, but afterwards it returned from

the wound. The ulnar artery was then tied below the wound, for it was apparent that the blood returned from below. What was next to be done if it should again bleed? Tie the radial artery. But it did not return. We see however the difficulties which overtake us when the primary branches are wounded near their trunks, and the surgeon will have to determine the propriety of tying the trunk, or of enlarging the wound, and tying the bleeding orifices. In this case there might have arisen a necessity for three operations instead of one. As it happened, it was dexterously done and happily."

As there is no name given with this case, and I cannot hurt the feelings of any one publicly, I shall take the liberty of saying there never was any thing done so directly contrary to the principles of surgery, in regard to wounded arteries. In the first place, for a wound of the ulnar artery, the brachial was tied, thus applying the Hunterian theory of aneurism to a wounded artery. In the second place, the ulnar artery was tied in a similar manner, some two or more inches below the wound, being an error of the same kind. This operation succeeded, because the collateral branches had not time to bring the blood into the arteries below the ligature on the brachial, and above that on the ulnar artery, before they were closed by the inflammatory and natural processes. This case therefore furnishes another proof of the fallacy of the opinions on the collateral circulation which I have just exposed. The reporter of this case does not however stop here, he comments upon it, by inquiring what was next to be done, if it had bled again? and replies

himself to the question—Tie the radial artery. Now it would be difficult to conceive why the radial artery should be tied for a wound of the ulnar, if the surgeon were not alarmed at the thought of dividing muscular fibres, in which the only difficulty lies. In order to avoid dividing muscular fibres, a separate and distinct artery is to be tied; and what could that operation have done? on what principle could it be useful? By tying the radial artery, the return of blood through it into the humeral end of the ulnar might have been prevented. But it would not *certainly* have been prevented, because there are radial, and ulnar, and interosseal recurrents, all returning blood, or capable of doing it, after the lapse of a few days, into the cut and open extremities of the artery, and they might all require to be tied in succession. If the opinions entertained on the subject of the collateral circulation by its strongest advocates were correct, they must and would all have required it.

The error in this case was original. The surgeon should have made a clean incision down to the artery, through all the muscular fibres interposed between it and the surface, avoiding the median nerve, which runs between the two origins of the pronator teres muscle, and then he should have placed a ligature above, and another below the wound in the artery, and there would have been nothing more to do.

The person's life was endangered, two operations were done, and a third, and probably amputation as a last resource, were only avoided by an accidental circumstance, *viz.* that the cut end of the artery became impervious before the recurrent and collateral branches

brought their blood round into it; and all this was incurred merely that a few muscular fibres might not be divided. It is necessary now to ask what would be the consequence of this division? The utmost consequence which could ensue, would be weakness of the arm in the performance of certain motions: but I have no hesitation in affirming that no such consequence would ensue. I have seen the parts divided, nay I have divided them myself, and the patient has recovered without any sensible defect. The following case is a strongly marked one on this subject. It was from it that I first drew this confirmation of my ideas on wounded arteries.

The corporal of pioneers of the 29th regiment, was wounded at the battle of Roliça by a musket ball, which passed through the anterior and upper part of the fore arm, fracturing the ulna. A few days after the injury, an artery sloughed and bled profusely. The surgeon in charge immediately tied the brachial artery above the wound, and in the night the hemorrhage recurred, and the man nearly bled to death. The arm was now amputated, and the ulnar artery was found in an open and sloughing state.

This man's arm would have been saved, if an incision had been made down to the artery, taking the shot-hole as a centre, and then, when the vessel was laid bare, placing a ligature on each of its divided ends.

At the battle of Vimiera, which followed a few days after, a soldier received a similar wound, save that the artery bled forthwith, and could only be stopped by the continued application of a tourniquet. I cut

down on the artery, through all the intervening parts, carefully avoiding the median nerve, and found the artery more than half divided, a ligature above and below the wound suppressed the hemorrhage, and it did not afterwards return.

The Baron Dupuytren has published a memoir bearing on this subject, entitled "Memoire sur les Aneurismes qui compliquent les fractures et les plaies d'armes à feu, et sur leur traitement par la ligature pratiquée suivant la methode d'Anel;" in the Repertoire General d'Anatomie et de Physiologie, &c., tome v, 1828, which it is necessary here to examine. The memoir is too long to translate entire. It begins by referring to the case related by Petit, in his Traité des Maladies des Os, tome ii, page 46, 1736, in which he made an incision into the leg of a person who had fractured both bones, and secured the injured artery, the patient recovering in the usual time.

The second case occurred to Pelletan. A coachman had the wheel of a carriage pass over both legs near the ankles; the left was broken, but without any wound; and in this state he was brought to the Hotel Dieu, the limb being greatly swelled. On the twenty-third day after the accident, the limb being still more swollen, and a fluctuation being felt in it, an opening was made about an inch long in the middle part; when a small quantity of pus was discharged, accompanied by a considerable quantity of clotted blood, which was shortly afterwards followed by scarlet arterial blood. Compression was made on the artery in the groin, and the flow of blood having been suspended (it appears from this that Pelletan and his

assistants knew how to compress an artery), it was decided that amputation of the thigh should be performed. This person eventually recovered : the dissection of the limb did not demonstrate the artery injured.

The third case occurred in the person of a man 55 years of age, who broke his leg obliquely at the upper part, which was treated in the usual manner. The patient having complained of uneasiness in the calf, it was particularly examined about the thirtieth day after the accident, when an aneurismal tumour was discovered. The limb was taken out of the splints, but in four hours it was so much swollen, and the mischief was so rapidly increasing, that it was considered proper to amputate above the knee. The peroneal artery had been injured. The stump was doing well, when the man was cut off by an attack of pneumonia.

In the fourth case, the patient, 30 years of age, broke his left leg, a compound fracture; there was a considerable bleeding at the time and for several days afterwards. On the fifteenth day, an abscess on the external part of the leg was opened, and pus and coagulated blood were discharged from it. Blood was discharged every day with the dressings, until the seventy-fifth day, when a violent hemorrhage supervening, an incision was made and compression was had recourse to; but this failing, the limb was amputated. The anterior tibial artery had been injured, and was open in five or six places. The man died seventeen days after the operation.

The fifth case is that of Martha Marie Bache, 62 years of age, who broke the left leg obliquely at the junction of the middle with the lower third, on the 2d

of January, 1809. On examining it next day, M. Dupuytren found a pulsating tumour in the calf, which he presumes was formed at the moment of the accident, by an injury of either the posterior tibial or the peroneal artery. He decided on placing a ligature on the femoral artery, in the middle of the thigh. The temperature of the limb never diminished in consequence of it. On the fifth day afterwards, the articular arteries of the knee could be distinctly felt; and on the sixth, the size of the tumour had diminished one third. The formation of the callus was slow, it had scarcely begun at the end of the first month, had very little consistence at the end of the second, and appeared to be quite solid only at the termination of the fourth. She was shortly afterwards discharged, cured of both aneurism and fracture.

In the sixth case, the patient, Jacques Boudet, 30 years of age, had his left leg broken (a comminuted fracture), the 8th of May, 1815, by the wheel of a car laden with hay. On his arrival at the Hospital St. Eloi, M. Delpech found the limb enormously swollen, and this swelling was accompanied by pulsations, which were very distinct near the calf, and more or less perceptible when compression was made on or removed from the femoral artery. It was decided to tie the femoral artery, which was done the next day, and the patient perfectly recovered, and was discharged on the eighty-second day, cured of both aneurism and fracture.

The seventh case, and the most important as bearing on our inquiry, I have translated more at length.

"M. de Gambaud, a captain of cavalry and aide-de-camp of one of our most distinguished generals, re-

ceived, February 10th, 1818, a wound from a horse pistol, which entered the upper part of the right leg, from the front backwards, and from the outside inwards, passing between the tibia and the fibula, which latter it slightly injured. A violent bleeding immediately ensued. A young surgeon seeing the blood gushing out from both openings, came to his assistance, and stopped the hemorrhage by the application of a compress and bandage, which permitted the removal of the patient to his house. The leg became swollen and very painful, to which succeeded an alarming numbness; nevertheless life remained in the limb, and no outward bleeding occurred till the thirteenth day; but during this time an internal effusion had taken place, and an aneurism was developed, which increased every day, and became more observable from its synchronous movements of expansion and contraction with those of the pulse.

"A tourniquet, in addition to the compress and bandage, suspended the beating of the tumour each time that it was applied to the femoral artery, or each time that it was screwed; but after some time, as it almost always happens, the column of blood made itself a passage by raising the pad, or by pushing the soft parts aside; the pulsations again took place, and daily increased, and the impulse of the blood soon forced out the coagula formed at the opening made by the entrance of the ball. The first hemorrhage took place on or about the thirteenth day after the wound. This bleeding was renewed several times in a few days, and greatly weakened the patient, in spite of the assistance, both internal and external, which was afforded him.

"It was then that I first saw M. de Gambaud, with Messieurs Aumont and Dessien.

"The foot and leg were of a violet colour, swollen, cold, and numb. On the upper part of the leg there was a swelling accompanied by tension, and a movement of expansion and contraction, synchronous with the action of the heart. There were two small round openings with unequal edges on this tumour, situated the one at the back of the leg near the fibula, the other on the inner edge of the calf. The first was where the ball entered, and the second where it came out. They both for a few hours had been closed by clots of blood, that each pulsation threatened to raise and force out. A tourniquet applied to the lower part of the thigh on the course of the femoral artery, would of course lessen the impulse of the blood; but could not prevent its getting to the tumour, and giving rise to frightful shocks.

"Such was M. de Gambaud's state; the wound that he had received, the first hemorrhage that he had sustained, the tumour which had been formed from the first moment that the blood had ceased to flow outwardly, the volume and tension of this tumour, the nature, extent, and strength of its movements, the repeated bleedings that the patient had suffered, all proved that the ball had destroyed one or several of the great arterial trunks in the ham.

"What was to be done? We could not again make use of compression, which had already been fairly tried, and had not prevented five or six hemorrhages taking place, which had reduced the patient to an alarming

state of weakness. Ought we to place a ligature on the extremities of the divided vessels?

"But what were those vessels? Was it the anterior or posterior tibial artery, or the peroneal, or the popliteal artery, or was it several of these at the same time?

"If it were one or more, how should we attack them, before or behind, or on these two points successively?

"But to all who know the depth at which these vessels are situated, their relation to the bones, muscles, and nerves, this project appears impracticable. Could we even determine exactly, which was impossible, which vessel was injured, how could we get at it? How could we distinguish it from the soft, torn, and bruised parts which would surround it? or how would the instruments and the threads necessary to tie a ligature be got to the bottom of a wound thus deep, and between the bones? The amputation of the thigh seemed the most prompt and safe remedy; and this was what my young colleagues wished, and only waited for my sanction to perform. Amputation is not however without danger, and in my opinion will kill three out of twelve, when practised even upon young and healthy persons, such as are chosen for its victims on the field of battle. I did not therefore recommend that it should be had recourse to, but advised the placing of a ligature on the femoral artery. If the event did not turn out as I expected, if the blood brought back by the collateral arteries continued to flow either at the superior or inferior extremity of the divided artery; or if from any other cause the ligature should prove insufficient, it would become the first part of an

amputation, neither more dangerous nor more painful from being performed at two intervals. My two colleagues and the patient himself, who was expecting to lose his leg, readily agreed to my plan, which I accordingly put into execution. The operation was performed in one minute, without the loss of a spoonful of blood, and with less pain than the application of the tourniquet had caused.

"The limb half bent, and resting on the outside, was placed on a pillow, the openings made by the ball were covered with lint, the aneurismal tumour was enveloped with thick compresses steeped in a strong solution of the acetate of lead; the rest of the leg and foot was kept warm.

"It was possible that the course of the blood might not be re-established, or mortification might be caused by want of nourishment in the limb, whose principal artery had just been tied; or, on the contrary, the circulation might return too rapidly, and again cause the hemorrhage the ligature was put on to prevent; or without that, inflammation, suppuration, and decomposition of blood in the wound, and in the focus of the aneurism, might cause serious accidents.

"This was the price and risk attached to the preservation of the limb. The youth and strength of the patient, and the permeability, which is one of the attributes of the vessels, did not leave much cause to fear that circulation would not soon be re-established.

"The attrition which the two ends of the vessel had suffered from the ball, and the presence of the blood with which they were surrounded, seemed to promise the obliteration of the vessels, and to prevent

the return of the hemorrhage, which the inopportune re-establishment of the circulation often causes.

"In the end our hopes were realized: heat, sensibility, and pulsation, were not for an instant suspended or altered. The circulation was kept up by the collateral vessels, which only nourished the limb, without allowing too much blood to flow to the ends of the divided vessels, so as to overcome the resistance offered by their swelling, and to produce new hemorrhages.

"The inflammation was moderate, in spite of the size of the wound, and of the quantity of the blood which filled the upper part of the limb, part of which was discharged by suppuration; the rest was slowly absorbed, but none was decomposed in the wound.

"The intervention of art after the operation, was confined to administering some antispasmodic medicines to calm the nervous state of the patient; to attention to diet, to ease of position to prevent the stretching or tearing of the parts, to repeated applications of remedies of a sedative nature to the aneurismal tumour, and to keeping the foot and leg warm, to support the circulation and life. Afterwards we had recourse to careful dressings night and morning, to disencumber the limb of the pus and blood discharged from the wound.

"We followed this plan until the twentieth day, when the ligature on the femoral artery came away. The wound in the thigh rapidly healed; that on the leg being less simple, of course took more time to cure. In fact, it was ten or twelve days before the whole of the blood was discharged; and during the fifteen

following days, the suppuration was abundant. About this time some pieces of leather, clothing, and bone, were discharged from the posterior opening of the wound. However, at the end of six weeks all the wounds were completely healed ; the limb was a little numb, rather red, and swollen at the upper part of the calf. But all this soon disappeared, and in three months M. de Gambaud walked as well as he had done before he had been wounded.

" Ought we to attribute the success of this operation to the accidental concurrence of fortunate circumstances ? or ought we look upon it as the natural and necessary consequence of the principle acted upon, in placing a ligature on the femoral artery ? and should such a method of proceeding be established as a precept in surgery ? To answer these questions, allow me again to mention, that this method of treating simple aneurisms always stops the pulsation of the tumour ; and even when employed against aneurism complicated with fracture has been very successful ; and, finally, that this method, which M. Delpech and myself first practised nearly at the same time, in cases of hemorrhage following amputation, has invariably been attended with success. From these results I think it evident, that the success of the present operation was not dependent upon any fortuitous occurrence ; but on the contrary was the natural consequence of the practice pursued. The ligature, in suspending the course of the blood in a divided vessel, the solution of continuity of which had caused an external and internal bleeding, gave time and means to the inflammation to cicatrize the wound

in the vessel, and to render the cut extremities impermeable to the blood which the anastomosing branches might bring to them.

"To judge by analogy, this obliteration ought to be more easy and more certain after gunshot wounds than any other.

"One of their most remarkable effects being to contract *(froncer)* the orifices of the vessel, to concrete or coagulate the blood contained in their extremities, and to render them impervious.

"Without therefore wishing to elevate this single fact into a principle, I do not hesitate to consider the success obtained in this case of M. de Gambaud as the forerunner of other similar fortunate results.

"Many other reflections occur to me, but I hasten to a conclusion, drawing attention to the two principal points of the memoir. First, the rupture of the principal artery of a limb, occasioned by a fracture, and followed by an extravasation of arterial blood round the broken bone. Secondly, the rupture of the principal artery of a limb caused by a musket ball, followed by an extravasation of arterial blood, having in both cases the character of an aneurismal tumour. This complication of injuries, either of which alone would be serious, had never till now been cured but by amputation.

"The ligature of the principal artery of the limb, made at some distance from the wound, and between it and the heart, will I believe prevent the necessity of this cruel mutilation."

Before I proceed to comment on M. Dupuytren's opinions, I shall relate several cases.

Case I.—Thomas Carryan, of the 3d regiment, was wounded at Albuhera, on the 16th of May, 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 for some minutes, when it ceased and 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 hemorrhage 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. The patient died a few days afterwards.

Case 2.—A private of the 5th division of infantry received a wound at the battle of Salamanca, which passed across the back part of the right leg, from above, downwards and inwards; the ball having entered about two inches below and behind the head of the fibula, and passing out near the inner edge

of the tibia. There was little blood lost at the time, and it was considered to be a simple wound; eight days after the injury, some blood flowed with the discharge on dressing the limb; this increased during the night, and on examining the limb on the morning of the ninth day, it was evidently injected with blood, which flowed of a scarlet colour from both orifices. It being doubtful which vessel was wounded, whether it was the trunk of the popliteal artery, or the posterior tibial or peroneal after its division into these branches, it was thought advisable to place a ligature on the femoral artery about the middle of the thigh, which suppressed the hemorrhage. The case was now shown to me, as one in proof of the incorrectness of the opinion I had a few days before stated, of the impropriety of such an operation being done. The seeming success did not long continue, a hemorrhage again took place from the original wound, and the limb was then amputated. The posterior tibial artery had been injured, and had sloughed. The man died.

Case 3.—James Murphy, of the 28th regiment, 22 years of age, was wounded at the battle of Waterloo by a musket ball, which passed through the thigh below its middle and in the course of the femoral artery, which was not wounded at the time; but as the wound began to heal, it gave rise to an aneurismal swelling in the part, for which the usual operation for aneurism above the seat of disease was performed by staff-surgeon Cole, on the 22d of July, 1815, two ligatures being placed below the artery, which was divided between them. The

pulsation in the swelling immediately ceased. On the 23d, it was observed that the discharge from the gun-shot wound was greater than usual, but every thing else appeared to be favourable, and the aneurismal wound bid fair to unite by the first intention.

25th. The aneurismal wound has suppurated; the gun-shot wound discharges good matter. Temperature of the limb natural; no pulsation in the swelling.

1st of August. The dressings much soiled by discharge, and when removed the wound discharged about two oz. of matter discoloured with blood. Both ligatures came away without the slightest resistance or hemorrhage.

6th. Has suffered pain in the wound for the last two days, the discharge is considerable, but the wounds look healthy.

8th. The discharge from the aneurismal wound is thin and watery, and mixed with a substance like coffee grounds; the health is good, and no pain in the wound, although it requires pressure to evacuate the discharge.

11th. Matter is evidently collecting in the thigh.

13th. A counter opening was made at the inferior part of the thigh, in the line of the aneurismal tumour, and over the exit of the ball, and two oz. of a bloody purulent fluid were evacuated; four oz. of blood were lost in the evening from the wound.

25th. Has been doing well since the 13th, until this morning, when, on rising to get out of bed, an arterial hemorrhage took place from the counter opening to the amount of about four oz.; pressure on the thigh

by the tourniquet could not stop it, but it was arrested by compress and bandage and the application of cold. The thigh in the evening appeared to be swollen.

26th. The bleeding recurred this morning, but was again arrested by pressure, but the thigh is enlarged and seems injected with blood. Amputation was now determined upon, and performed. The man sunk and died two hours and a half afterwards.

Dissection of the Limb. An incision was made in the direction of the aneurismal wound about an inch deep, which exposed the sac, containing a large quantity of coagulated blood of a dark colour, although destitute of fetor; the blood was not alone confined to the sac, but was extravasated throughout the limb, the quantity altogether being at least one pound and a half. Another incision was made towards the knee, somewhat in the direction of the artery; and upon opening the tumour, which was beneath the fascia, there spouted out three ounces of thin matter of the colour of clay. No communication whatever could be found between this encysted abscess and any other part.

The course of the ball was then traced, and it was found to pass through the rectus, vastus internus, and sartorius muscles, and common integuments; it was beneath the abscess but higher in the thigh, and immediately over that part of the artery which was diseased, but did not touch it, having passed through the body of the sartorius muscle. It was very evident that the ball in its passage was the cause of disease in the parts around the artery and of the vessel itself, but the injury was not sufficient to bring on imme-

diate hemorrhage, otherwise it would have occurre, in the field. The vessel being destroyed by the progress of disease, and not by the immediate application of the ball to the vessel, there was neither matter nor foreign body discovered within its track; it immediately communicated with the counter opening, and with that part where the blood was effused.

In taking up the vessel at first, it was not thought necessary to secure it below the aneurism, which must have been done in the popliteal space, the vessel being diseased just before it entered the triceps. It was supposed that the tumour would be absorbed as in popliteal cases, and that the anastomosing branches would be obliterated, which was not the case; for those vessels seem to have brought back the blood to the artery, and from thence into the sac, contrary to its natural course. This was very evident, for no other vessel could be found opening into the tumour or sac; and when the vessel was traced from the popliteal space to the diseased parts, its coats were found to be completely destroyed; that part of the vessel above the ligatures was completely obliterated for nearly two inches in length, with a coagulum of an inch and a half in length, extending to within about half an inch of where the profunda is given off.

The bone never was injured, and was found to be in a most healthy state.

Case 4.—Lieutenant Colonel M'Pherson, 92d regiment, received a wound from a musket ball on the 13th of December, 1813, which entered a little in front of the trochanter major femoris of the left side, between the rectus and vastus externus muscles, and having struck the os

femoris which flattened it, passed underneath the anterior edge of the glutæi muscles, and along the ilium for about three inches, and lodged in the posterior part of the belly of the gluteus maximus, from whence it was cut out next day.

This course of the ball was in a straight direction, as he was on horseback when he was wounded: he lost a great quantity of blood at first, so much that he did not feel himself able to undergo the fatigue of being carried the distance of two leagues to the hospital station at Cambo, for two or three days afterwards; but he continued to go on well and to recover his strength till the 27th of December, when he began to complain of pain and heat deeply seated in the wound, and was a little feverish and restless, for which he took a purgative and opiate at night, but without relief. On the 28th, the parts were observed to be more swollen, the pain was increased, and about noon a sudden and violent hemorrhage ensued from the posterior wound, by which in two or three minutes he lost upwards of two pints of blood. Compression was made on the mouth of the wound for some time, which restrained the flow of blood externally; but it appeared that hemorrhage was still going on internally. A firm hard compress of paper rolled up in a bandage was placed along the course of the posterior part of the wound, and bound tightly on it; the parts were kept very cool with vinegar and water; and gentle manual pressure, by a relief of servants as they became tired, was kept constantly on the pad, with a view to obliterate the artery by these means.

In the afternoon, a swelling in extent about the size

of an egg, but not so thick, was observed to be forming below the pad, two inches from the orifice of the wound; he had for some time begun to feel a gradual increase of pain from the pressure, and whilst changing his posture in bed, the orderly removed his hand for a moment, when another gush of coagulated and of red arterial blood escaped, which weakened him but gave him ease.

29th. The parts were considerably swelled, tense, and of a glazed appearance about the centre of the course of the wound; and some blood forced its way out by the anterior orifice, to which an additional compress was applied.

On the 30th, he complained much of the pain caused by the pressure and the pad, and that he could not sleep or rest for it; and as it appeared that the internal hemorrhage was still going on, a consultation was held concerning the propriety of cutting down on the bleeding vessel to tie it, which was agreed to in the event of any further alarming hemorrhage ensuing.

About four o'clock in the morning of the 31st, the pressure having been removed, as he was not able to endure it on account of the dreadful pain it gave him, another profuse hemorrhage took place; which reduced him so much that his extremities became quite cold, his countenance pale and shrunk, and his pulse was hardly to be felt.

It was stopped as before. In the course of some hours he recovered his warmth, his pulse rose, he became tolerable hearty again and took some breakfast, but it was evident that the bleeding would return, and that it was going on internally; that notwithstanding the

pressure it had still continued forming a sort of false aneurism, which burst forth when it came to a certain size (latterly at longer intervals, as his strength and the force of the circulation diminished), and therefore it was determined to perform the operation, as no other remedy seemed to afford any prospect of saving his life,

At 11 A. M. the operation was performed by staff-surgeon Murray. A large probe was first introduced at the posterior orifice, to ascertain its course and the depth to be cut: two firm pads were put along the course of the incision, and held firmly by two assistants to prevent bleeding.

A large mass of coagulated blood forced its way out as soon as the incision was made, and was followed by florid arterial blood. The wound was immediately sponged out and the pressure of the pads removed a little, when two large branches of the gluteal artery which had been cut in the first incision presented themselves, and were tied on the side next to the origin of the artery, and then at their opposite orifices, by the use of the needle. The parts were again cleaned out by a sponge; and in the course of the original wound, immediately below the former vessel, a large artery was found close upon the bone, from which all the secondary bleedings had taken place; it was included in a ligature, and all bleeding from that part entirely ceased. Its opposite orifice appeared to have been included in the second ligature, as the needle was passed nearly quite down to the ilium. The intention of the operation was now so far accomplished; two other small muscular branches were afterwards taken

up, and the lips of the wound then brought together by slips of sticking plaister, with a compress of lint on each side, and a flannel bandage to support the whole.

Although he did not lose above four oz. of blood directly from the arteries by the operation, he became much exhausted before it was finished, and indeed we were not without some fears that he would have sunk during its performance.

Fifty drops of laudanum were given to him, and he was left on his bed where the operation was performed, without moving him any more than to take away a wet blanket which was below him, and to introduce a dry one. Perfect tranquillity was enjoined and observed about him, and he took two or three table-spoonfuls of chicken broth.

For some time he suffered from that anxious restlessness attendant on exhaustion and extreme debility, and from pain and irritation; but when by rest the powers of the system began to recover from the shock, the equilibrium of the circulation to be restored, and the opium to exert its influence, he became very composed and easy; his pulse got up; his countenance recovered a degree of vivacity; he said he felt himself much better than before the operation, being more free from pain in the seat of the wound, and his mind was more at ease from the idea of the vessel having been secured; he got a tolerably refreshing sleep of three or four hours, interrupted only at intervals by starting.

January 1st, 1814. He passed a tolerably easy night, slept at intervals, and took a little nourishment, but had also symptoms of great exhaustion with alterna-

tions of chills and flushings, and clammy perspirations, and now and then sickness and hiccup. The parts about the wound were comparatively easy but hot; there was no oozing of blood; he took a mouthful of toast with a dish of tea to breakfast, was in good spirits, but inclined to doze and sleep much. During the day his appetite failed. Towards evening he began to sink very rapidly, and died at eleven o'clock, P. M.

On examining the state of the parts after death, it was found that no adhesion had taken place.

It is evident that the operation ought to have been done in the first instance. The only cause of delay arose from the thickness of the muscular parts to be divided, and the dread which at that period filled the minds of most surgeons upon this subject; a dread which it is to be hoped will be for the future abandoned.

CASE 5.—Jean Debret, a French prisoner of war, came under the care of staff-surgeon Collier, in the beginning of September, having been wounded at the battle of Waterloo by a musket ball, which broke both bones of the left leg, and requiring several incisions to be made into the soft parts, which were greatly implicated by disease. He had suffered an attack of erysipelas, and the constitution had sympathized greatly with the injury, and was little able to resist it. Towards the end of the month, the wound assumed the character of the hospital sore or gangrene, which spread rapidly over all the parts down to the tibia. The extensor tendons were dissected bare for the space of four inches, and the interosseous membrane even appeared to have partaken of the disease. On the

4th of October, hemorrhage took place about two inches and a half above the ankle joint, which was arrested by pressure. On removing this and some coagula which covered the artery, it bled furiously; a little dissection laid the artery bare an inch and a half above this spot, when a ligature was passed around it, and the bleeding never returned; the ligature came away on the sixth day. The man recovered and was sent to France, with a serviceable leg although lame.

Hospital gangrene often gave rise to hemorrhage, which led to securing the vessels as near as possible to the part affected. I have tied the external iliac, the femoral, humeral, radial, ulnar, and anterior tibial arteries, in consequence of their being opened by this disease. In the early part of our treatment of this complaint, most of these cases were lost from the extension of the disease to the wound made by the operation. In the last campaign, when local destructive measures were adopted to arrest its progress, this extension of disease did not always take place; and the last case of this kind on which I operated, which was that of a soldier at Santander, who had been wounded at the battle of Vittoria by a musket ball in the leg, and in whom I tied the anterior tibial artery, was saved in a most satisfactory manner.

Case 6.—"Osten Cooper, of the 2d batallion 1st regiment of guards, thirty years of age, was wounded at the battle of Waterloo, on the 18th of June, by a musket ball, which entered the left groin a little below Poupart's ligament, passed through the thigh, and was cut out the following day a little above the smaller trochanter. Nothing remarkable occurred until the

29th, when the slough from the anterior wound came away, and was followed by so frightful a hemorrhage as to leave no doubt from whence it proceeded, nor (from the wound being so high up) any alternative as to the means to be adopted for stopping it. The external iliac was therefore immediately exposed, secured by a double ligature, and divided; the ends of the artery immediately retracted more than half an inch. The sides of the wound being now brought together by adhesive straps, the operation was finished without loss of blood; indeed arterial action was so high, that twenty ounces of blood were taken from the arm; the limb was rolled in flannel, and warm jars kept to the foot.

June 30th, passed a good night, a tingling sensation in the limb, amounting to pain in the heel. Has had free evacuations, no pain in the bowels, nor tension of the abdomen; had, however, yesterday, a severe rigor, followed by heat, and which was succeeded by profuse sweating, which he calls an ague fit; of which there can be no doubt, as he asserts that he has had a similar paroxysm every other day, nearly at the same hour, ever since he was wounded. A good deal of pus had collected in the gunshot wound; and some had insinuated itself into the incised one, thereby in some measure loosening the straps, and allowing the sides to open a little. In the evening, excitement continued with thirst and nausea. Saline draughts were given in a state of effervescence: he remained on spoon diet with whey.

July 1st. During the night the excitement was increased, with oppressed respiration; twelve ounces of

blood were taken from the arm, which gave relief. In the morning the pulse was rather feeble, the abdomen continued soft and free from pain, the bowels open. The pain in the chest was removed, but the breathing was hurried. The discharge from the old wound, sanious. Vespere. A peculiar pulse, giving the idea more of the ebb and flow than of the progression of a fluid. No rigor during the day, or tenderness of the peritoneum. The incised wound looking well, but part of the sides kept from actual contact, by the insinuation of pus from the old one.

2d. Pulse less tremulous ; low delirium occasionally, but is easily recalled to his recollection. Tongue moist. Had a copious evacuation after the laxative enema. The limb has acquired its natural temperature, and the abdomen continues free from pain or tension. Vespere. The stroke of the pulse more distinct.

3d. Passed a tolerable night, although the delirium is now constant. Belly free from pain, soft and regular. The camphorated saline medicines were now succeeded by tonics and wine. Noon. Countenance flushed ; pulse very feeble. Evening. Great exhaustion ; pulse scarcely to be counted ; tongue brown and parched ; the temperature of the skin exceedingly high ; cold affusion ; increased quantity of port wine and bottled porter ; bark with mineral acids.

4th. The typhoid symptoms increased ; picking of the bed clothes ; subsultus tendinum. One involuntary stool ; tongue exceedingly parched ; the temperature of the skin high ; cold sponging with vinegar ; stimulants and antiseptics. Vespere. Stupor and increase of debility.

5th. Insensibility and involuntary stools. Stertorous breathing. Cold extremities. Noon: Expired.

In this case the necessity of the operation is evident, and as far as it went, also its success. Not a drop of blood was lost after it. That the patient died from intermittent fever, running into the continued form, and that of the typhoid type (induced probably by loss of blood), no one, who has observed the endemic disease of this climate, will be inclined to doubt.

Case 7.—I published the following case fourteen years ago, in the 7th vol. of the Transactions of the Medico-Chirurgical Society, and yet the old operation is the only one to be found in surgical works.

Henry Vigarelie, a private in the German legion, was wounded on the 18th of June, at the battle of Waterloo, by a musket ball, which entered the right leg immediately behind and below the inner head of the tibia, inclining downwards, and under or before a part of the soleus and gastrocnemius muscles, and coming out through them, four inches and three quarters below the head of the fibula, nearly in the middle, but towards the side of the calf of the leg. In this course it is evident that the ball must have passed close to the posterior tibial and peroneal arteries; but as little inflammation followed, and no immediate hemorrhage, he was considered to be one of the slighter cases. On the latter days of June, he occasionally lost a little blood from the wound, and on the 1st of July a considerable hemorrhage took place, which was suppressed by the tourniquet, and did not immediately recur on its removal. It bled however at intervals during the night; and on the morning of the

2d, it became necessary to re-apply the tourniquet, and to adopt some means for his permanent relief.

Having gone to Brussels after the battle of Waterloo, this man was shown to me by my friends Messrs. Campbell and Hill, surgeons to the forces, under whose care he was, and who were desirous of avoiding an amputation, if possible, although the site of the wound, and the uncertainty of the vessel wounded, as it bled from both openings, rendered it doubtful.

The man had lost a large quantity of blood from the whole of the bleedings, his pulse was one hundred and ten, the skin hot, tongue furred, with great anxiety of countenance: the limb, from the application of the tourniquet from time to time, was swelled, a quantity of coagulated blood had forced itself under the soleus in the course of the muscles, increasing the size of the leg, and florid blood issued from both openings on taking the compression off the femoral artery. On passing the finger into the outer opening, and pressing it against the fibula, a sort of aneurismal tumour could be felt under it, and the hemorrhage ceased, indicating that the peroneal artery was in all probability the only vessel wounded.

In this case there was, in addition to the wound of the artery, a quantity of blood between the muscles, which in gunshot wounds accompanied by inflammation is always a dangerous occurrence, as it terminates in profuse suppuration of the containing parts, and frequently in gangrene. The evacuation of it therefore became an important consideration, even if the hemorrhage had ceased spontaneously.

The man being laid on his face, with the calf of the

leg uppermost, I made an incision near seven inches in length in the axis of the limb, taking the shot hole nearly as a central point, and carried it by successive strokes through the gastrocnemius and soleus muscles towards the peroneal artery, which I attempted to discover, but this was more difficult than might be supposed, after such an opening had been made. The parts were not easily separated, from the inflammation that had taken place, and those in the immediate track of the ball were in the different stages, from sphacelus to a state of health, as the ball in its course had produced its effect upon them, or their powers of life were equal or unequal to the injury sustained.

The sloughing matter mixed with coagulated blood readily yielded to the back of the knife, but was not easily dissected out. The spot which the arterial blood came from was distinguished through it, but the artery could not be perceived, the depth of the wound rendering any operation on it difficult. To obviate this inconvenience, I made a transverse incision outwards, from the shot hole to the edge of the fibula, which enabled me to turn back two little flaps, and gave greater facility in the use of my instruments. I could now pass a tenaculum under the spot from whence the blood came, which I raised a little with it, but could not distinctly see the wounded artery in the altered state of parts, so as to secure it separately. I therefore passed a small needle, bearing two threads, a sufficient distance above the tenaculum to induce me to believe it was in sound parts, but including very little in the ligature, when the hemorrhage ceased; another was passed in the same manner below, and

the tenaculum withdrawn. The coagula under the soleus were removed, the cavity washed out by a stream of warm water injected through the external opening, the wound gently drawn together by two or three straps of adhesive plaister, and the limb enveloped in cloths constantly wetted with cold water. The patient was placed on milk diet.

On the 4th, two days after the operation, the wound was dressed and looked very well; the weather being very hot, two straps of plaister only were applied to prevent the parts separating. On the 5th, a poultice was laid over the dressings, in lieu of the cold water, the stiffness becoming disagreeable. On the 6th, as the wound, although open in all its extent, did not appear likely to separate more, the plaisters were omitted, and a poultice alone applied. On the 8th and 9th it suppurated kindly; and on the 10th, or eight days from the operation, the ligature came away, the limb being free from tension, and the patient in an amended state of health, his medical treatment having been steadily attended to.

From this period the cure went on, although slowly, without accident; a small abscess formed at the inner and lower edge of the soleus muscle, but closed shortly after its contents were evacuated. The wound was entirely healed in three months, but the leg was bent on the thigh, and required mechanical means for its extension.

The length of the fibula is sixteen inches. The cicatrix of the wound made by the ball is four inches and three quarters below the head of the fibula. The sound limb, four inches and three quarters from the

head of the fibula, is thirteen inches and three quarters in circumference. The limb operated on eleven inches and three quarters, being a diminution of two inches. The length of the cicatrix is six inches and a half. The artery was tied therefore by computation one inch and a quarter below where it is usually given off by the posterior tibial.

The man is now in the York Hospital at Chelsea, and walks about without appearing lame, although he cannot do so for any great distance. He suffers no pain, except an occasional cramp in the ball of the foot, and some contraction of the toes, which takes place generally when he rises in a morning, and continues for a minute or two, until he puts them straight with his hand; this I do not attribute to the operation, but to some additional injury done to the nerves by the ball in its course through the leg.

In the remarks which I am going to make on the memoir and opinions of M. Dupuytren, I hope that I shall not deviate from that respect which is due to a foreigner and a gentleman of high and deserved reputation. M. Dupuytren is pleased to entitle his operation after the method of Anel, although it was not done according to the method of Anel, but after that of Hunter; neither did Anel ever do an operation in the same place, or on the same principle. If the Baron had shown himself to be thoroughly acquainted with the principles that directed Mr. Hunter in the performance of his operation, I should have thought that the omission of his name might have arisen from a jealousy of his posthumous fame, unworthy of the elevated rank which M. Dupuytren himself holds in

the profession; but it clearly arises from inattention to the principles laid down by Mr. Hunter and his successors, and to the difference which really exists between these operations.

It is also very extraordinary the Baron should say, as he does, page 22, that he had consulted in vain both ancient and modern authors on this subject, when the first and seventh of the cases I have given above were published, with several others nearly similar, in Paris, nine years before his memoir appeared, by Breschet in his translation of Mr. Hodgson's work on the Diseases of Arteries and Veins. It is nevertheless very satisfactory that it should be so, because it shows that the practice which M. Dupuytren recommends to the French surgeons in 1828 as worthy of their adoption, had been tried in the British army in 1810 and 1812, and proved to be ineffectual, and to be founded on erroneous principles; whilst, in 1815, the true method of proceeding had been demonstrated by the same surgeons, and established on safe and scientific principles.

It will not be matter of surprise, that I should disagree in opinion with M. Dupuytren, when he asks the question, "Ought we to attribute the success in the case of M. Gambaud to the accidental concurrence of fortunate circumstances? or ought we to look upon it as the natural and necessary consequence of the principle acted upon in placing a ligature on the femoral artery? and should such a method of proceeding be established as a precept in surgery?"

To support his opinion, that this case should lead the way towards erecting the practice pursued into a precept in surgery, he is forced to consider cer-

tain points as facts, which have never been demonstrated to be facts: but I shall give his own words.

"The ligature, in suspending the course of the blood in a divided vessel, the solution of continuity of which had caused an external and internal bleeding, gave time and means to the inflammation to cicatrize the wounds in the vessel, and to render the cut extremities impermeable to the blood which the anastomosing branches might bring to them.

"To judge by analogy, this obliteration ought to be more easy and more certain after a gunshot wound than any other.

"One of their most remarkable effects is to *(froncer)* contract the orifices of the vessels, to concrete or coagulate the blood contained in their extremities, and to render them impervious."

This last passage cannot be admitted as a correct statement of the effects of a gunshot wound on arteries.

I have shown in the preceding observations, pages 231 et seq. what is the real effect of a ball on the extremity of a divided artery, and that the appearances depend very much on the size and structure of the vessel. In what manner a ball can contract *(froncer)* the orifices of an artery has never been shown, neither can it be easily understood; inasmuch as the act of contracting must be a vital act dependent on the powers of the artery itself. If it be a mechanical act, arising from injury, it must be a contusion; and this surely cannot be advanced as a process likely to consolidate the end of the vessel; it being now well known and admitted in England, that the first and most simple

state of adhesive inflammation is the best calculated for the permanent closure of a divided artery.

A torn, divided, or injured artery, may suffer several kinds of injury. I shall include them under three heads: First, where the artery is only injured, but not opened into. Secondly, where it is fairly divided, or partly divided by a musket ball. Thirdly, where it and the surrounded parts are torn and contused by a cannon shot.

I have said, when on the structure of arteries, that they possess an elastic and resisting power, which enables them to yield in a great degree to an opposing force without being torn, and to suffer a degree of contusion, which would lead to sloughing in other parts with little comparative injury.

I have published the case of Captain Flack in my work on Gunshot Wounds, page 330, in which several inches of the femoral artery were laid bare by a cannon shot, and were seen for three weeks pulsating in the usual manner, until gradually covered over by granulations. In this case the artery maintained its life and functions unimpaired.

At the battle of Albuhera, Captain Gibbons, of the fusiliers, was wounded by a musket ball, which passed immediately below the clavicle, and out behind, so directly in the situation of the axillary artery, that it was supposed it must be injured. Great inflammation followed in the chest, and his life was saved with difficulty. He died of phthisis last winter; and on examining him particularly, I found that the artery was obliterated at the part where the ball I presume had passed by the side of it. I have seen however a great many instances in which no such event

followed. The present governor of the Cape of Good Hope, General Sir Lowry Cole, was wounded when advancing with the 4th division of infantry to attack the French centre at the battle of Salamanca. The ball passed under the clavicle, injured the first rib close to the artery, and passed out behind, without implicating the artery or giving rise to any inconvenience. At the first siege of Badajos, two officers of the 40th regiment met with injuries nearly similar; and I have seen the subclavian artery as well as the carotid fairly divided, but then death immediately ensues. In the case of a French prisoner, after the battle of Salamanca, I was obliged to apply a ligature on the axillary artery, which had not bled for several days until the artery sloughed. The patient had unfortunately a shot also through the chest, of which he died in the night; and he was stripped and carried off at daylight next morning, so that I had no opportunity of examining into the nature of the injury. The fact of arteries yielding a passage to a ball, and recovering themselves and their situation without rupture or sloughing, is well shown in the case of Turnbull, page 241, and is I believe sufficiently established to require no further confirmation; but the capability of doing this is dependent on a power residing in the blood-vessel itself; and when a slight injury results, the first perceptible sign of derangement is that of inflammation. A greater extent of injury leads to sloughing or ulceration of a part or the whole of the circumference of the artery, or a part or the whole may be carried away.

If the whole be carried away, the appearances I have described take place. If only a part of the

artery be torn, or cut into, or slough, the patient will generally bleed to death, unless assistance be obtained; the musket or other ball having no effect on the walls of the artery different from any other instrument. Where a part of the vessel remains uncut, the opening made by the sword or ball, if small, becomes round from the unequal retraction of the artery. The contraction of it depends on the *perfect* solution of continuity of the vessel, and the liberty which the cut fibres thereby attain of contracting. If the artery be merely slit up, the sides of the opening will come in contact, so as not to be very perceptible if the artery be compressed above, and no blood be allowed to pass through it.

At the battle of Talavera, my attention was drawn to a soldier, who had just died exhausted, after a considerable loss of blood, from a wound by a musket ball, which passed through the pectoral muscle in the direction of the axillary artery, making its exit behind. I divided the muscle to see what injury had occurred to the artery, and found it cut more than half across, having been struck too directly to escape by its elasticity. In this case the extremities of the vessel could not retract nor contract, and the man bled to death. I have heard of other cases of the same kind, and it is quite plain, that in them no resource was left but in a ligature applied both above and below the wound.

When a cannon shot strikes a limb, and bruises it most severely, without carrying away any part, constituting a sort of injury which I have explained page 128 of my work on Gunshot Wounds, the great artery

or arteries may be ruptured, not only in one spot, but the internal coat may be injured in several. I have given an account of one particular case, in which, on dissection, it was found that the posterior tibial and fibular arteries were torn across, and the popliteal artery, two inches higher up, was closed by coagulable lymph thrown out from a rupture of the internal coat of the artery at this part.

When a large artery is wounded in man by a sharp cutting instrument, to the extent of one-fourth of its circumference, or even less, I believe the process of cure always takes place through inflammation, and by the obliteration of that part of the canal of the vessel.

The master tailor of the 40th regiment, tempted by the approaching prospect of plunder, was induced, on the night of the assault on Badajos, to give up the shears, and arm himself with the halbert. At the foot of one of the breaches allotted to the 4th division, he was properly rewarded for his temerity by a wound from a pike in the right arm, from which he says he bled like a pig, and became very faint. On his arrival at the spot indicated for surgical assistance, he actually fainted; but this was attributed to the unwarlike propensities of the man, rather than to any just cause; and as the wound was apparently trifling, he was sent into camp. It gave him no material inconvenience the next day, but was shown to me afterwards by the surgeon, Mr. Boutflower, in consequence of the coldness and loss of power of the arm. The wound was not more than one-third of an inch long, a little below the edge of the pectoralis major, and immediately over the artery; the arm and hand were numb

and cold, the pulse was not distinguishable at the wrist, and it appeared to cease at the place of injury, which was harder and a little more swelled than natural. He said that his pulse had always been felt by the doctors in the usual place. I took him into my house, and the wound healed without any trouble, attention being paid to keeping the arm warm by covering.

On the 20th, the hand was much colder than the other, but not painful.

On the 21st, the pulse was distinguished at the wrist for the first time, but very faint. He this day left Badajos with me for the banks of the Douro, and accompanied my baggage, riding and walking by turns; the natural temperature of the arm gradually returning, and complaining only of a numbness and the want of strength in his arm, which he carried in a sling.

On the 1st of May, the pulsation of the artery could be felt a little below the wound, and on the 6th it was distinguishable, but faintly, along the lower edge of the biceps, in which state it now remains. The arm and hand are stronger, but he still carries them in a sling. The heat is natural; yet on any exertion he has a good deal of unpleasant numbness in the thumb and fore-fingers. There is a small cicatrix at the place of the wound, which is otherwise quite natural to the touch. I think the median nerve may have been injured: that the artery was wounded, there can be no doubt, and also that it has healed without the least assistance from art, although it is impervious at the part injured.

I consider myself then warranted in saying, first, that when an artery is injured by a ball, but not torn or bruised to such an extent as to destroy the continuity of the vessel, inflammation is the only result; secondly, that when the artery is cut or divided, the processes I have described take place; thirdly, that in some cases, particularly where the injury is inflicted by cannon shot, the internal coat may be torn in one or more places above the part where it is divided, constituting a barrier to the flow of blood from the part; but it must be recollected that this barrier is formed at a very early period. I much doubt whether blood would pass through such an artery: I am sure that it would not do so twenty-four hours after the injury. The impulse or power of the heart or circulation is as nothing when the inner coat of an artery is injured, and has inflamed so as to throw out coagulable lymph. It invariably arrests the circulation and obliterates the artery.

In all cases in which an artery is seen pulsating on the surface or other part of a wound, the obstacle to the bleeding is found to exist in the very extremity of the vessel: let only one-sixteenth part of an inch be cut off, and the blood immediately darts forth. I have done this fifty times at least, and it is precisely the same from whatever cause the injury is inflicted.

A divided or cut artery, in a case of wound by a musket ball, is not in a more favourable state for healing without hemorrhage than from any other wound. In regard to the other observation of M. Dupuytren, that a gun-shot wound has the remarkable property of concreting and coagulating the blood in their extre-

mities, in a greater degree than any other wound, it is contrary to every fact I am acquainted with in regard to large arteries. The theory then which he would build on these opinions is untenable. If the wound had such an effect on the artery, why did it bleed at first? why did it continue to do so afterwards? I have shown that the lower end of the artery is more likely to bleed than the upper, and that hemorrhage does not always depend on the impulse of the circulation. It is certainly true that if the blood can be prevented from passing into the divided vessel, there will be a greater chance of the natural processes of inflammation and granulation, which are taking place in and around it, closing it up, than if the blood be allowed to flow through it. But it is only then a chance. It is impossible to calculate the time which nature may require to bring the blood by the collateral vessels into either the upper or lower end of the vessel; it may occur immediately; it may not do so for hours or for days; and on the speculation that it may not do so, the first hope of safety depends; the second, on the further accidental circumstance, that the end of the artery may be closed in the interval. Surely this cannot be considered a scientific operation, and fit to be erected into a precept in surgery, which depends on two accidental circumstances, neither of which can in the slightest degree be calculated upon.

There are many other reasons why the operation was a bad one in this case, and always will be a bad one in all similar cases. The patient was made to undergo the chance of mortification of the extremity, which it is probable would have taken place, if the operation had not been delayed until some days after

the first hemorrhage occurred from the wound; which did not take place until the thirteenth day, during which time the inflammation in the limb had given the collateral vessels a disposition to enlarge. The wound itself was not treated as the principles of surgery require. A quantity of decomposed blood was pent up under and between the muscles of the calf of the leg, together with some of the patient's clothes, and some spiculæ of bone. Surely in a case like this, but without further fear of hemorrhage, the Baron would have enlarged the wound, cleared away the clots of blood, and have placed it in a simple state. There cannot be a doubt on the subject, and the operation of making an incision through the muscles of the calf of the leg would have enabled him to do all this, and to have secured the vessels, if there had been even four bleeding extremities, without any difficulty or danger.

The Baron Dupuytren applied Mr. Hunter's theory of the operation for aneurism to the treatment of a wounded artery, and succeeded by chance; others have done the same long before him; but nothing which is dependent on chance or accident can ever become a principle in surgery.

The theory is not always applicable even when the wounded artery forms an aneurism, because the whole limb is not in the same state as one which has gradually become aneurismal from disease of the artery. The following case, which occurred to staff-surgeon Collier after the battle of Waterloo, forcibly exemplifies this fact.

"John Morrisy, of the second battalion of the thirtieth regiment, aged 24, of a full and masculine habit, was

admitted into St. Elizabeth's Hospital, under my care, Thursday, August 24, for aneurism of the femoral artery of the right side; the tumour was about three inches in length, and two in breadth, and extended to within an inch of Poupart's ligament. The pulsation was powerful, and gave the feeling of a strong thrill, with considerable resistance to the propulsion of the blood; there was a cicatrix where a ball had entered on the top, about two and a half or three inches from Poupart's ligament; the skin was not discoloured; the limb was of the same temperature and plumpness as the other.

"I learned that the patient had been wounded by a musket ball on the 18th of June, which had penetrated at the cicatrix alluded to, and had remained in the limb; that he had lost a considerable quantity of blood at the time, but that nothing particular occurred during the healing, and that he had been discharged the hospital apparently cured, on the 12th of July. On the 17th of July he was placed as orderly in the Notre Dame Hospital, where he continued, being at times very dissipated, until the 18th of August, when, being unable to go on with his duties, he for the first time showed the tumour to the medical officer in charge, and was instantly taken under treatment.

"This hospital being broken up, was the cause of the patient coming under my care on the day stated.

"The aneurism I considered to have been formed by the injury done to the vessel, in the passage of the ball, and to have been consequently of two months duration; the constitution was vigorous and good,

and fearing lest the pulsation or any loss of health might occasion the cicatrix to ulcerate, I determined not to delay securing the external iliac artery, an operation which I judged to be requisite in order to save life, and to be urgently called for, from the visible enlargement of the tumour. He was confined to bed, kept on spare diet, and the bowels were evacuated preparatory to the operation, which I performed on Monday, August 28, at twelve, in presence of Mr. Gunning, surgeon in chief, Mr. Neil, deputy inspector, Dr. Wray, physician to the forces, and most of the medical officers at Brussels.

"I made a semicircular incision, which began three-fourths of an inch from the interior of the inner ring, had its base on Poupart's ligament, and terminated at about one inch and a half from the anterior superior spinous process of the ilium, horizontally with the commencement. The fascia of the external oblique, after being exposed, was detached from Poupart's ligament, to the same extent and in the same direction; on turning it up, the lower edge of the internal oblique, and the beginning of the cremaster muscles, with the spermatic cord passing through the inner ring, were distinctly seen. Some fibres of the internal oblique, having their origin from the ligament, were then divided in order to give room. The cord was held aside with the flap formed by the incision, while I enlarged the inner ring with the handle of the knife, and detached the peritoneum with my finger, so as to enable me to feel the artery, which I found covered by, and closely connected to some small glands, the largest of which I removed. Having separated the

artery, I passed a director under it, and the gentlemen present being satisfied it alone was raised, I passed a probe armed with a ligature along the groove, and secured it: the pulsation in the aneurismal tumour instantly ceased. The edges of the wound were approximated by one suture. Two small arteries sprang during the operation, but there was no blood lost deserving the least consideration.

"In one hour after the operation the patient felt easy; the pulse was 90 and soft; the heat of both limbs much alike, and somewhat below the natural temperature. At four there was a great diminution of heat on the whole limb, and the foot and toes were quite cold; he was anxious, and complained of great numbness; hot flannels were applied, and used with gentle friction; bottles filled with hot water were fixed to the soles of the feet, and along the leg. At seven the anxiety had increased, and the pain was excessive, with a sense of great coldness; he tossed about and was very restless: some discoloured patches were discovered on the calf of the leg. Through the night the pulse was generally full, varied from 80 to 92, and for a time intermitted; he was irritable, and the countenance anxious; complained of the most excruciating pain, the same feeling of coldness, and want of power over the leg; was otherwise easy. Two anodyne draughts were administered, but he slept little or not at all; towards morning he thought himself easier. The warmth to the limb was kept up the whole night; but the instant the applications for this purpose were removed, the temperature sunk.

"Through the day of the 29th, the anxiety and rest-

lessness rather increased, accompanied with the same pain and numbness; the discoloured patches had enlarged; the skin was soft, the pulse full, with hardness; it never exceeded 100; tongue white and moist. Two doses of castor oil were administered, but without effect on the bowels; the limb was lightly swathed in flannel, and men were kept constantly sitting by his bed-side to keep their hands on his leg and foot; the hot bottles continued; during this night he slept well, but complained of excessive pain whenever he awoke.

"On the 30th, the wound of the operation was dressed, and appeared irritable; the pulse was full and very hard; the tongue white and moist; the skin hot; expressed himself easier, but was restless, and complained of the same want of feeling; thermometer on the thigh rose to 86°; small doses of neutral salts were administered every three hours; and sixteen oz. of blood taken away, which was buffed and cupped. The patient seemed generally relieved by the subtraction of blood, but complained of aching pains below the knee. Two spots of sphacelus appeared about the ankle joint; bowels were evacuated towards the evening, and the evacuations were natural; he slept but little during the night; was in much pain, and tossed about in great anxiety; perspired at times freely. On the morning of the 31st the pulse had risen, was very full and hard; the patient complained of pain over the abdomen, increased by pressure; the wound was highly inflamed; twelve oz. of blood were taken away; it was found equally buffed and cupped with the former; the bowels were kept open, and poultices applied to the wound. He appeared better and easier through this day, than

at any time since the operation; the limb had a cadaverous odour. Towards night the pulse being still hard, and having still pain of abdomen, eight oz. of blood were further subtracted. The thigh was discoloured; there was no increase of natural heat, or diminution of the sense of numbness, or of the general restlessness. He passed the night in great anxiety and distress, and in the morning the whole limb, for some three inches above the knee, was livid, and had vesicated in several places. He took a little wine at times through the day, but the constitutional powers gradually sunk, and he died at four in the afternoon of the 1st of September.

"Dissection. On opening the abdomen in the usual manner, there appeared a general flush of the intestines; the reflected peritoneum was of its usual transparency, and the cœcum was adhering to it by lymph over the iliac muscle. The ligature was found on the artery close to Poupart's ligament, about an inch below the giving off the circumflex, and some quarter of an inch from giving off the epigastric. The wound of the operation was made as I intended. There was a small communication between the femoral artery and vein at the side of the tumour, about an inch and a half below the origin of the profunda; on the superior part the covering of the aneurism was formed by the sheath of the vessels and the fascia of the thigh. The profunda was neither thickened nor enlarged. The whole limb was in a state of gangrene."

In this case an aneurism in the upper part of the thigh was formed in consequence of an injury. The operator, according to the theory of aneurism, tied the external

iliac, and the patient died of mortification. Where was the error? In having recourse to Mr. Hunter's theory of aneurism, which directs the artery to be tied at a distance, because it is diseased in the neighbourhood of the part which is affected by aneurism. But in this case there was no previous disease, the artery was sound, and the old operation of cutting into the sac should have been done, or that of Anel, in preference to that of Mr. Hunter. If in this case the artery had been tied immediately above the sac, some important collateral branches would not have been cut off, and the patient might not have died of gangrene. It inculcates also an important lesson, that when an aneurismal tumour is rapidly formed, and operated upon at a very early period, the collateral branches have not always had time to enlarge to such a degree as to carry on the collateral circulation, and the patient is lost, when a little more delay might have been attended with a very different result.

A gentleman met with an accident at Chatham, by which his thigh was broken. No further injury was suspected, although the lower and internal part of the thigh swelled very much, until the toes began to turn black and mortify. At this point my opinion was requested by letter. The reply was, amputate the limb above the fracture forthwith, or you will lose your patient by the extension of the mortification, which eventually took place. If the mortification had not taken place, there was nothing required to be done but to await the progress of the diffused aneurism, and the consolidation of the fracture, and then to place a ligature as near the injured part of the artery as circumstances would

permit, at a reasonable period of time after the accident, so as to allow time for the enlargement of the collateral branches.

When a deep-seated branch of an artery is wounded, and continues to bleed, considerable difficulty often arises as to the best method of proceeding. It is a very different case from a wound of a main trunk, the course and situation of which are well known, and are as easily found. It is possibly an uncertain branch from which the hemorrhage proceeds, such as one of the large vessels given off by the profunda femoris, or in the fauces, or one of the deep-seated branches in the hand or foot. The facility of communication between the anastomosing branches is here a point of great importance for consideration. The following case will perhaps be explanatory.

A private of the name of Wilson, of the 23d regiment, was wounded at the battle of Salamanca by a musket ball, which entered immediately behind the trochanter major, passed downwards, forwards, and inwards, and came out on the anterior part, but on the inside of the thigh. The ball by its course could not have injured the femoral artery, although it might readily have divided some branch of the profunda, in all probability of the internal circumflex. On going round the hospital at ten o'clock at night, several days after the receipt of the injury, I saw this man with his leg out of bed, another holding a candle, and a third catching the blood which flowed from the wound, and which had half filled a large pewter basin. They seemed to think it would stop in due time, having bled once before during the afternoon. I put a tourniquet with a thick pad as high as possible on the

upper part of the thigh, and directed the orderly to make pressure above it, requesting the officer on duty to loosen it in the course of an hour, which was done, and the bleeding did not recommence. The next day I placed the patient on the operating table, removed the coagula from both openings, and tried to bring on the bleeding by pressure and by moving the limb; it would not however bleed. As there could be no other guide to the wounded artery, which was evidently a deep-seated one, I did not like to cut deep into the thigh without it, and the man was replaced in bed, and a loose precautionary tourniquet applied. At night the wound bled smartly again, and the blood was evidently arterial. It was soon arrested by pressure. The next day I placed him on the operating table again, but the artery would not bleed. This occurred a third time, and with the same result. The bleedings were however now almost immediately suppressed, whenever they took place, by the orderly who attended upon him; care having been taken to have a long thick pad always lying over the femoral artery, upon which he made pressure with his hand for a short time. The hemorrhage at last ceased without further interference, and the man reoc-vered.

This case was to me one of considerable interest, more particularly because I had not decided in my own mind what operation should be done. I did not like to place a ligature on the femoral artery above the profunda, neither was I quite satisfied with the idea of tying the profunda an inch below its origin. It was on this account that I was desirous that the wound should bleed at the moment of operating, as my finger

introduced into it might lead to the spot from whence the blood flowed, whilst I might also be guided in forming my opinion, by the manner in, and place at which pressure caused it to cease. I might have tied the profunda, but I certainly would not have tied the superficial femoral artery. My intention was however to ascertain if possible whether the wounded artery would be more easily got at by a transverse incision on the fore or back part of the thigh, and to proceed accordingly. In a similar case I should introduce my finger into the wound, and enlarge it transversely, continuing the incision until the opening was sufficiently large to see to the bottom of the wound or the bleeding part. It is necessary to be attentive to the course of the great vessels and nerves, but not to the safety of muscular fibres, the division of which leads to no permanent injury. I am aware, that as pressure on the main trunk led to the ultimate suppression of the hemorrhage, it may be said, that a ligature placed high up on the femoral artery would not only have done the same, but would have relieved the man from the anxiety necessarily dependent on the momentary fear of a recurrence of the hemorrhage. There are two objections to this method of proceeding: the likelihood of mortification taking place, which I have sufficiently shown to be in similar cases a probable occurrence; and the possibility of the hemorrhage being renewed through the anastomosing branches. The temporary suspension of the circulation by pressure does little or no harm, more particularly where the pad used is so thick as to cause it to fall principally on the artery, and only in a slight degree on the surrounding parts, which by

a little attention may be readily accomplished. I have succeeded in many instances of hemorrhage from less important places, by proceeding in this manner; but I selected this particular case to ground the proper line of practice upon, because it was of more importance than most of those which usually fall under the observation of the surgeon. It is not good practice to cut down upon an artery on the first hemorrhage, unless it is so severe or so well marked as to leave no doubt of its being the main trunk of the vessel itself; nor is it then advisable to do it except the artery continues to bleed; for many a hemorrhage, supposed to have taken place from the main trunk of an artery, has been permanently stopped by a moderately continued pressure exercised in the course of the vessel, and sometimes continued with compression on the bleeding part itself.

This subject must also be pursued further. Hemorrhage may take place from an artery which cannot be tied at the part where it is wounded, as in the throat; and the question of placing a ligature on the main trunk under this particular circumstance must now be considered.

The following is the most curious case of this kind with which I am acquainted.

A soldier, in the year 1805, complained to me of sore throat, difficulty of breathing, and general oppression and uneasiness in the chest, which he said arose from certain blows received from the serjeant major at drill, in consequence of his being exceedingly awkward. No proof could however be brought of the blows or ill treatment, although it was admitted that

he had been drilled for several hours daily, to make him keep his shoulders back, but in vain. The fauces were slightly reddened. After a few days the throat became more inflamed, although not to any great extent, and he was utterly incapable of swallowing any thing but liquids. This was followed by a ptyalism, as if under the influence of mercury, which induced me to tax the man with having made himself ill, but he would not acknowledge it, although I promised him a pardon on telling the truth. He soon began to spit blood, of a light scarlet colour, but without any cough; and this increased in quantity daily, until at last the orderly informed me there was a coagulum in the bottom of his spitting pot every morning, equal to six or eight ounces of blood. The ptyalism continued, the throat not worse, the breathing free, and so little apparent cause of hemorrhage, that I again taxed him with having done something to himself out of spite to the serjeant major, who he constantly charged with having been his death. I made him sit by me for an hour, whilst I was seeing all the other sick, and pressed him to confess, telling him that when he died, which he would soon do, I should as certainly find out on opening him what he had done. He persisted that there was nothing wrong about him, but what was the effect of the injury he had received on his chest from the serjeant major. He was soon observed to be constantly spitting or hawking up blood, and became very white and emaciated; and in a day or two afterwards the blood began to pour out of his mouth so rapidly, that he called to the orderly to bring me. I arrived however

only in time to see the blood pour out of his mouth as if by vomiting into the chamber-pot, which was filled with it, when he fell back dead. On opening the body, I found an instrument lying across the commencement of the œsophagus, composed of two half phial corks, fastened together by strong thread, having previously had three pins each thrust through them, so that the heads of the pins were applied to each other, back to back, the points sticking out beyond the cork, forming a sort of chevaux-de-frise: this, it is presumed, he covered with fat, and attempted to swallow; but the point of a pin catching, the efforts to swallow turned the machine across. In this situation the points of the pins were close to the carotid arteries, and having by degrees given rise to ulceration of the œsophagus, they wounded them on both sides; every elongation or pulsation of the arteries having brought them against the point of one or more of the pins, the marks of which were observable in several small holes of different sizes on the sides of the vessels. As one or two of these became larger, from the constant attrition, blood came through into the œsophagus; and as these again increased by ulceration, larger holes were formed, from which the sudden and fatal hemorrhage took place. The manner of its occurrence could not be mistaken; and the instrument and the arteries, which I sent from North America to Dr. Hooper, and which are in his museum, attest the fact.

The three following cases, published, the first by Staff-surgeon Collier, the second by Mr. Mayo, the third by Mr. Luke, bear upon this subject. The second and third are much abridged.

Case 1.—William Ball, drummer, belonging to the 44th regiment, aged between nineteen and twenty, of a spare habit, was wounded by a spear or sword, on the 17th of June, which passed in at the angle of the left jaw, and penetrated the mouth, lacerating the tongue severely in three or four places. He was brought into St. Elizabeth's Hospital on the 19th, and had, by his account, lost a considerable quantity of blood on the way; but from this time until the 22d nothing remarkable occurred. On the evening of the 22d I was sent for to see him, and found arterial blood jetting up with considerable force from the bottom of a narrow deep wound, and flowing in different directions as if from several branches of the external carotid. I attempted dilatation; but as all efforts to trace the sources of bleeding were fruitless, I applied steadily and forcibly graduated compresses, moderating the flow of blood by pressure on the carotid. Although the hemorrhage yielded for three or four minutes, it was soon evident it had only changed its channel, for it began to flow as furiously through the mouth as it had before done through the wound, and the coagula required to be constantly removed to prevent suffocation. The patient's countenance had now become pale, the pulse was hurried and feeble, every appearance indicated the rapid sinking of life from the loss of blood, and my opinion being, that the patient's preservation depended on securing the common carotid artery, I performed the operation at eight o'clock that evening; the hemorrhage ceased the instant the ligature was applied. In two hours after

the operation, the patient was quite tranquil and sensible; the pulse feeble; countenance very pale. On the following morning (23d), I found him perfectly sensible, and easy, with the exception of some sense of heat in the throat, rather increased since the operation; the pulse was 96, with slight sharpness; no appearance of hemorrhage; the bowels were opened by small doses of calomel and jalap. The wound was dressed on the 25th, and looked healthy; pulse feeble, and varying from 112 to 120. On the 26th, he complained of a ringing noise in his left ear, and some sense of numbness on the left side of the face. From this time until the 2d of July, nothing occurred which could cause much alarm: the pulse was seldom below 110; the skin was of its ordinary temperature; the right carotid pulsated with greater force than ordinary; the sensorium was no way disturbed; there did not appear to be any want of blood on the left side of the head. The patient's bowels were kept open by neutral salts, and his diet was of the lightest kind. On the 2d of July, slight erysipelas commenced over the parotid gland on the left side, spread over that cheek and eyelid, causing some tumefaction, and slightly affecting the opposite side. It was mild, vesicated in a few places, and subsided in five or six days, under a treatment of mild purgatives and cooling applications. On the 5th of July, the ligature came away from the artery, and the cure appeared to be more progressive and steadier than could well have been expected from a constitution shaken by former illness. On the 12th of July, a second attack of erysipelas com-

menced, in its site and degree similar to the former, and yielding like it to mild treatment. The man was discharged cured the 12th of August.

Case 2.—John Webb, ætat. 23, was admitted into the Middlesex Hospital on the evening of the 18th of October: those who brought him, stated that he had suddenly lost a considerable quantity of blood from an ulcer in the fauces; but the hemorrhage had now stopped, and no apprehension was entertained of its immediate return.

The next morning however, towards nine o'clock, the bleeding burst out afresh, and in a few minutes two quarts of blood were lost. The house surgeon, Mr. Laidlow, hastened to the ward, and with great promptness compressed the carotid artery on the affected side, when the hemorrhage ceased. Notice being sent to me of what had happened, I went instantly to the hospital, and found the patient faint to the last degree, pale and bloodless.

On examining the fauces, I saw a ragged clot of blood adhering to the right side of the pharynx, while the left tonsil and adjacent surface appeared clear and healthy. I proceeded therefore, without loss of time, to tie the right common carotid in the middle of the neck. Scarcely a drop of blood flowed from the incision made for this purpose; the pulse in the artery, when it was exposed, was exceedingly feeble; the internal jugular vein lay shrunk and collapsed.

On the 3d of November, the fifteenth day after the operation, the ligature came away from the artery. The ulcer of the pharynx had began to cicatrize, and the patient shortly afterwards recovered.

Case 3.—T. B. ætatis 45, a tall, rather muscular man, of sanguineous temperament, captain of a coasting vessel trading between Cornwall and London, had the misfortune to take cold on his passage, and was affected with sore throat.

September the 30th. Three weeks from the commencement of his illness, I was called to him about four o'clock in the morning, in consequence of his having lost a large quantity of blood. He had been awakened by something flowing from his throat, which proved to be blood. When I arrived he had already lost half a wash-hand basin full of blood; and shortly after he vomited more than two pints of coagula, making altogether between four and five pints lost in about half an hour. I found him in the greatest state of exhaustion; his pulse was scarcely perceptible, and very rapid. There was extreme paleness of the lips; the eye sunk in the orbit; a clammy sweat upon the skin; inclination to vomit; and he could not speak louder than in whispers. On attempting to examine the throat, I could see nothing behind the soft palate, to which were adhering shreds of coagula. In a short time he began to revive, and his pulse became more perceptible. Ordered one grain of the acetate of lead, with a quarter of a grain of opium, every two hours; Goulard lotion, with equal proportion of spirit, to be applied to the throat; the head to be elevated on a pillow, to be kept perfectly quiet, and abstain from swallowing as much as possible.

October the 3d. About 4 p. m. I was again called; bleeding had returned, but had ceased before my arrival. In about a quarter of an hour he had lost be-

tween three and four pints of blood; his pulse however was not much reduced in strength, nor increased in frequency, nor did he appear much exhausted. He spoke in whispers, and complained of the throat, and pointed to the left side of the os hyoides as the seat of pain. From this part, during the bleeding, he felt a jet issue into the throat. Ordered to continue the acetate of lead and opium, and in addition half a grain of powder of digitalis every two hours.

October the 4th. At 4 A. M. bleeding again returned. From the account I received I expected to find my patient dying or dead. I found him in the greatest possible state of exhaustion; faint to nausea; the pulse with difficulty to be felt and very rapid; the breathing laborious, and extreme paleness of countenance. He was sensible, but apparently indifferent to surrounding objects. He had lost at this bleeding more than three pints of blood, and it seemed almost certain that he must die. After a short time however, he began to revive; the pulse became more distinct, and breathing more free, but the powers of life were so far reduced that another bleeding would inevitably prove fatal. I therefore determined to tie the carotid artery on the left side, that being the trunk which the circumstances of the case indicated to be the source of the bleeding vessel. The operation succeeded in stopping the bleeding, which recurred once, seven days after the operation, and to the amount of two ounces. The two ligatures, which had been applied about half an inch apart without dividing the artery between them, came away on the twenty-second day after their application, and the patient perfectly recovered.

I was sent for into Jermyn Street to see a gentleman, who in a moment of great anxiety of mind had cut his throat with a razor, and fell bathed in blood. Assistance being at hand, the bleeding was arrested by thrusting sponges into the wound until I arrived. On examination it was found that the cut had been made with great violence across the throat, but was deepest on the left side, having laid bare the left carotid, and wounded the internal jugular vein, from which the principal bleeding came. The opening in the vein being distinct, I passed the point of a tenaculum through the edges made by the cut into it, and drawing them together in this manner, passed a single thread around so as to close the opening, without destroying the continuity of the vessel. The ends of the ligature were cut off close to the knot. The carotid was now clearly seen by the side of the vein, having a transverse mark or cut upon it, which did not appear to penetrate beyond the middle coat; and after due consideration, it was presumed that this wound might heal, without requiring a ligature to be placed upon the artery, which I was not desirous of doing, supposing that the vein would be obliterated; and that the obliteration of both vessels might prove a more dangerous impediment to the circulation through the head than it could suffer. On the eighth day arterial hemorrhage took place, and on opening the wound, it came evidently from that part of the carotid which had been cut. I placed a ligature upon the common carotid immediately below this opening, but the flow of blood was scarcely diminished in quantity by it, in consequence of the reflux from the head.

On attempting to apply another ligature above the opening, I found, as I had before suspected from the situation of the wound, that it was immediately below the division of the common carotid into the external and internal carotid arteries. The hemorrhage ceased on placing a ligature on the external carotid, and as the patient was greatly exhausted, I refrained from tying the other. The bleeding did not return, but he died the next morning from weakness.

On examination after death, the internal jugular vein was found pervious, and without a mark indicating where the ligature had been applied. The origin of the internal carotid was filled for about a quarter of an inch with a soft coagulum of blood, the remaining part up to its entrance into the skull was empty. The wound was exactly below the bifurcation of the artery: I preserved the parts.

This case will serve as a guide and beacon in practice under similar circumstances. It shows, that where an opening is only made into a vein of the size of the internal jugular (its division not having been accomplished), a ligature may be made to include the cut portion without interfering with the canal of the vessel; a practice which is always followed in wounds of the intestines; and that where the two outer coats of a large artery are divided, it will be better to place a ligature above and another below the injured part, than to leave it to the efforts of nature alone.

A direct wound of the common carotid is usually fatal from loss of blood. I have stated elsewhere that I had seen cases of this description, but had not been in time to be useful. There are, however, some few

recorded in which the patient recovered. In one case of this kind, in a soldier of the rifle brigade at Ypres, who was wounded by a penknife, staff-surgeon Maling tied the common carotid above and below the wound, and succeeded in arresting the hemorrhage, although the patient did not eventually recover. The practice in such cases is clear, and ought to be decided.

In all cases of hemorrhage from the throat, which cannot be suppressed without tying the carotid artery, it is the external carotid which ought to be tied, and not the trunk of the common carotid. There is not sufficient reason for cutting off the supply of blood to the head by the internal carotid, unless the operation on the external one should fail, when the internal or common carotid may be tied as a last resource. When there is even reason to believe that the lingual artery is the vessel from which the bleeding comes, it is yet advisable to tie the external carotid in preference, inasmuch as the collateral circulation will be more certainly suspended, and for a longer period of time; during which it is to be hoped the part from which the hemorrhage came may take on other and healthier actions, tending to the obliteration of the canal of the artery.

Wounds of the hand and foot, accompanied by hemorrhage, and which may be considered to be deep-seated wounds, are often exceedingly troublesome. The same rules are however applicable to them — dilatation of the wound, and ligature of the vessel; or if this is not practicable, or is unsuccessful, compression on the principal trunks, and graduated compress and bandage on the wound. The ulnar artery when wounded

in the palm of the hand ought always to be secured by ligature. The radial being deeper seated requires more precaution; and when an incision cannot be made of the necessary extent without injuring the median nerve or its branches, so as to paralyse the fingers, compression of both kinds should be tried. If the swelling of the hand will not admit of it, the radial artery should be first tied, then the ulnar. If the bleeding recurs in spite of the graduated compress, and the swelling of the hand will not admit of its reapplication, the hand is still not to be amputated, but a clean and decided incision is to be made in the line of the wound, from the annular ligament to the finger (avoiding the flexor tendons), and down to the metacarpal bone, which bone and the finger is *if necessary* to be removed; by which space will be obtained to see the bleeding vessels. The hand is only to be amputated as a last resource. The foot is to be treated in a similar manner. I have seen many cases of hemorrhage from both; but I never saw either removed in consequence of it.

Wounds inflicted on arteries in bleeding ought to be treated on the principles laid down for the management of wounded arteries generally. Whenever an accident of this kind occurs at the bend of the arm, an incision should be made down to the artery, and one ligature applied above and another below the wounded part. It is almost always the brachial artery that is wounded, and not the ulnar or radial, unless the latter is given off high in the arm. This practice would be seldom followed by any bad or unfavourable result if it were immediately adopted; but as the error

is usually made by persons incompetent to the performance of the operation, the bleeding is in the first instance restrained by pressure, until repeated recurrences of it render other assistance necessary. The arm is then in all probability more or less injected with blood, inflammation has taken place, the constitution can scarcely have failed to sympathize, and the operation under these circumstances is frequently ineffectual; amputation follows, and death. The following case may serve as an example.

A poor man had the artery opened at the bend of the arm in bleeding, and the operator, suspecting the accident he had committed, applied a compress and bandage to restrain the hemorrhage, which nevertheless recurred several times; on which he was sent to the hospital, with the arm now inflamed, swelled, and injected with blood. The brachial artery was tied close to the wounded part; but as the bleeding returned, it was again secured a little higher up; but as hemorrhage again took place, amputation was had recourse to, and the patient died exhausted. On dissection, the brachial artery was found to be the vessel injured, immediately at its bifurcation, so as scarcely to allow of a ligature being applied to the trunk below. In this case, three ligatures would perhaps have been required in the first instance; one on each artery, *viz.* the trunk of the brachial, and the commencement of the radial and the ulnar arteries. I have preserved the parts.

When the wound in the artery is of a small size, an operation is not always absolutely required, but that can be rarely ascertained until the incision is made, or

until it is found that the injury is not followed by bad symptoms. When the operation is not performed, and pressure is applied, it is possible that the wound in the artery may heal; but this does not usually take place, and an aneurism is the consequence. This may be of two kinds: circumscribed or diffused. If the artery has been punctured below the bend of the elbow, by an operation on the median basilic vein, the aponeurosis of the biceps muscle is interposed between the vein and the artery, and will tend under pressure to confine the effused blood, so that at last the inflammatory process will consolidate the surrounding parts, and if the external wound close, give rise to a circumscribed aneurism. For this, the operation of placing a ligature on the trunk of the artery must be had recourse to as near the aneurism as possible; the principal reason for doing it at a distance, *viz.* the diseased state of the artery, being wanting; and one ligature will be sufficient.

When the artery is wounded above the edge of the aponeurosis of the biceps, and the external wound closes, the effused blood may extend upwards in the course of the vessel, so as to form a diffused aneurism. These injuries are now of rare occurrence in England, and my opportunities of seeing them have not been so frequent as to enable me to lay down rules for their treatment with that confidence with which I write on all other points. I shall therefore refer to the best authority I know — to the recorded opinion of Dr. Colles of Dublin, as stated by Mr. Harrison,—accidents of this kind being apparently more common in that

city and in its vicinity than in London and its neighbourhood. He says, "I have operated repeatedly, and with success, for the cure of brachial aneurism, in consequence of injury to the artery in performing venesection. I have also frequently assisted others in operating for the same cause, and with the same result; and I never yet found it necessary to open the aneurismal sac, or to look for the vessel below the tumour, or to apply more than one ligature around the artery, and which I think ought always to be tied as near as possible to the seat of the disease." This method of treatment, combined with moderate pressure along the aneurismal sac, the horizontal position, and if necessary active depletion, will rarely fail of success, and cures have been effected by these methods even without the operation.

If the back part of the wounded vein should adhere to the cut edges of the wounded artery, leaving a direct communication between the one and the other; the blood is propelled into the vein, enlarges it, and constitutes what is called an *aneurismal varix*. But if there be any cellular texture interposed between the opening in the artery and vein, yet communicating with both, it gives rise to the change of denomination to *varicose aneurism*. Neither of these complaints, which are essentially the same, require an operation in the generality of instances; and after attaining a certain size and appearance, often remain stationary through life. When either from the increase of size of the swelling, or the anxiety of the patient, an operation is considered necessary, it should be done by

incision at the part, and the application of two ligatures to the artery; for although in some cases one has been found sufficient, in others the blood has returned into the sac by the anastomosing branches regurgitating into it, and a second operation has been required to effect a cure.

CONCLUSIONS.

1. When a large artery is divided and bleeds, the wound should be enlarged if necessary, and a ligature placed on both the divided ends; but if the artery be only injured and not quite divided, the ligatures should be applied one above, the other below the injured part. The artery may or may not be then cut across, at the pleasure of the operator, but the limb or part must be placed in the relaxed position. A bandage should not be applied, and the edges of the wound should be simply brought together by adhesive plasters, which do not extend completely round the limb.

2. If muscular fibres intervene between the artery and the surface, they should be divided, if they cannot be readily turned aside, so as to give a clear and distinct view of the wounded vessel and its accompanying veins or nerves.

3. If the wound pass indirectly to the principal artery, from the back of the thigh for instance to the femoral artery in front, or from the outside of the arm to the humeral artery on the inside, the surgeon may (on satisfying himself of the part likely to be injured, by the introduction of a probe) cut down on the vessel

opposite that part supposed to be wounded, by the most simple and approved method. When the artery is exposed, the probe will point out the spot at which the vessel has in all probability been wounded. Pressure made below this spot on the artery, will cause it to be distended and to bleed, if the flow of blood be not prevented from above; when the artery is to be secured by two ligatures, and the lower one should if possible be applied first.

4. A tourniquet should never be applied in an operation for aneurism or for a wounded artery. Compression by the hand is allowable in the course of the vessel when wounded.

5. The blood from the upper end of a divided artery, or that nearest the heart, is of a scarlet arterial colour.

6. The blood from the lower end of a divided artery, or that which is furthest from the heart, is of a dark or venous colour, when it happens to flow immediately after the division of the vessel. At a subsequent period it may assume more of the colour of arterial blood, but it rarely does so for several days after the receipt of the injury, and always flows, or at least until a very late period, in a continued stream.

7. This regurgitation or flow of blood from the lower end of a divided artery is a favourable sign, inasmuch as it shows that the collateral circulation is in all probability sufficient to maintain the life of the extremity.

8. The collateral circulation is in almost every instance capable of maintaining the life of the upper extremity when the axillary artery is divided.

9. The collateral circulation is not always capable

of maintaining the life of the limb when the femoral artery is injured. It is scarcely ever equal to it when the vein is divided at the same time, or rendered impervious.

10. The collateral circulation is sufficient to maintain the life of an extremity in almost every case in which an aneurism has existed for seven or eight weeks, although it might be incapable of doing this if the principal artery had been suddenly divided, without any previous disease having existed in the part.

11. The theory and the operation for aneurism are never to be applied to the treatment of a wounded artery, whilst the external wound communicates with the artery, unless it is impossible or impracticable to tie the bleeding vessel.

12. When an artery is wounded, and the external opening heals, so as to give rise to a diffused or a circumscribed aneurism, it is to be treated according to the theory of aneurism occurring from an internal cause, with this difference, that as the artery is sound the operation may be performed close to the tumour; and that if any doubt exists as to the capability of the collateral circulation to support the life of the extremity, the operation should be performed at the injured part, as in a case of wounded artery. See Mr. Collier's case, page 310.

13. When a circumscribed or diffused aneurism has been opened, whether by accident or design, it is then placed in the situation of a wounded artery, and must be treated as such, unless the wound can be permanently closed. If the aneurism has arisen from disease of the vessel, and the wound or opening into

it cannot be permanently closed, the limb is in a worse state than if the artery had been wounded by accident; because a ligature or ligatures placed on a diseased artery is little likely to be successful. It is liable to all the difficulties and inconveniences attendant on the old operation for aneurism.

If a case of the kind should occur in a popliteal or femoral aneurism, situated at or below where the artery passes between the triceps and the bone, amputation will be the best remedy. If the swelling should occur higher up, and the opening can be closed with a prospect of its healing, a ligature may first be placed upon the artery above it; but on the recurrence of hemorrhage, the artery must be tied below, or recourse be had to amputation. It is, however, to be observed, that amputation under these circumstances, when resorted to as a third operation, rarely succeeds.

14. When an artery is wounded with a simple fracture of a bone, or with a comminuted fracture of smaller bones, with an external communicating opening, both ends of the artery are to be secured, and the limb is to be treated in the usual manner.

15. When the bone broken is the femur, and the artery divided is the femoral artery, the operation of amputation will generally be advisable. It will always be so if the fracture is a comminuted one, or the shaft of the bone is extensively split.

16. When the broken bone injures the artery and gives rise to an aneurism, the treatment is to be first of the fracture and then of the aneurism, as soon as circumstances render it advisable or necessary to have recourse to the operation for aneurism.

17. When mortification takes place in addition to, or as a consequence of a wounded artery, amputation should be had recourse to forthwith.

18. The place of operation should be in almost all cases at the seat of the original injury ; but there may be an exception ; *viz.*

19. When the injury has been a mere cut, just sufficient to divide the artery and vein, immediately below Poupart's ligament, and mortification of the foot supervenes, amputation should be performed at the place of election just below the knee.

This rule is founded on the observation, that great efforts are made by nature to arrest mortification a little below the knee. Sometimes they succeed ; when they fail, death is inevitable ; and on the fact that amputation at this part or above the knee is less dangerous than at the great trochanter. The life of the part of the thigh left between the injury and the amputation will in all probability be maintained ; and under the worst of circumstances, a chance yet remains by the high operation.

The nature and extent of the original injury may admit of some variation in the practice, but the general rule only is given.

20. When mortification has commenced, and has continued for several days, and is spreading without having once stopped, the constitution of the patient being implicated as marked by fever ; the amputation should not be performed until the mortification has been arrested and the line of separation has been formed. But,

21. If the mortification has once stopped and then

begins again to spread, it will never again cease to extend, and an amputation may give some chance of life.

22. When an aneurismal tumour mortifies, it is unnecessary and improper to tie the artery above the tumour, because it will be obliterated if the mortification is arrested by the efforts of nature, which the operation may interfere with, and even prevent. Whilst, if the mortification spreads, it will be a matter of supererogation, and only hasten the patient's dissolution. When an aneurism inflames, and is opened by ulceration, it is a proper case for amputation, if such an operation can be performed. See No. 13.

23. When mortification takes place after the operation for aneurism, the surgeon must be guided by the state of the patient's constitution, in resorting to or refraining from amputation.

24. When hemorrhage takes place from the surface of a stump, the artery should be tied at the part from which the blood comes; but if the bleeding proceeds from several small vessels, and cannot be arrested, the principal trunk should be tied above the diseased part, and the patient removed to a purer atmosphere.

ANEURISM BY ANASTOMOSIS.

This name was first given by Mr. John Bell to a disease of the smaller arteries of the body, which causes them to enlarge to a dangerous extent, and admits of many varieties, giving rise to external appearances which are essentially dissimilar, although requiring similar modes of treatment; the difference being dependent on causes, which, as far as our knowledge extends, influences the treatment only in a slight degree. This affection of the smaller arteries, in which the veins partake, is often a congenital complaint, when it is called a nævus maternus, under which and other names are included small spots on the skin, moles, and various cutaneous marks. It is only, however, when these spots or marks are subcutaneous, that they can be properly considered as approaching to the nature of aneurism by anastomosis.

The milder kinds of subcutaneous disease, to which the name of nævus is often applied, differ much both in appearance and size; sometimes remaining stationary through life, at others even disappearing altogether, or becoming small solid prominences. A nævus is usually of a red colour, with a bluish cast, shining through the skin, which appears to be exceedingly

thin. It has also a tolerably defined and terminating edge; and the disease of the vessels seems to be, and is confined to the part discoloured, or extends to a very short distance around it. The tumour or nævus, although large and elevated in size, does not pulsate. An aneurism by anastomosis in its most formidable shape, is a swelling of a more or less elevated character. The skin is in general thicker, and the colour is sometimes but little altered, although it more frequently has a bluish cast, which may even tend to red. The pulsatory nature of the tumour is marked and distinct, and the vessels, both arteries and veins leading to or from it, are enlarged for some distance. The tortuous form which the veins particularly assume, give to this disease a distinct character, which cannot be mistaken; causing it in some instances to appear like a bundle of earth worms closely connected with each other; whilst in some cases the central part has all the appearance of an aneurism by dilatation. The nævus is often dangerous from its liability to hemorrhage if the surface is abraded or ulcerated, even from the birth of the infant; and when at first of large size, it rapidly increases: when small, it will often remain stationary through life, or only be brought into action by some irritating cause. The aneurism by anastomosis is slow in its formation, and may for years have been considered as a nævus, before it suddenly begins to increase. The pain which accompanies it is great, and affects the part in its immediate vicinity. When it is for instance in the head, the pain is often intolerable, the hemorrhage on the least

abrasion of surface is frequently profuse, and the anxiety it gives rise to altogether, renders the patient willing to undergo any operation.

It is natural to conclude, that the dissimilar characters these complaints occasionally assume, must depend on some difference in the nature as well as in the extent of the disease, and it is probable that the opinions which have been formed on this subject have arisen from the examination of diseases of different kinds, although so generally resembling each other, as to cause them to be included under the same name.

An aneurism by anastomosis was supposed by Mr. J. Bell to be a congeries of dilated vessels filling the cellular substance through which they run, and in some degree resembling the manner in which the comb of the cock is injected with blood. It has also been considered to bear a resemblance to the structure of the corpus cavernosum penis. Others have likened it to a sponge. It is probable there are varieties of diseases, in which one or other of these appearances may be more observable. Dissection has shown, that in some instances the tumour has been formed by contortions and reflections of the vessels alone, whilst in others the sponge-like appearance has been more distinct. My observations and dissections have led me to the conclusion, that in some nævi, the character of contorted vessels is more distinct than in others; and that in nævi of large size and marked characters, as well as in aneurism by anastomosis, the disease essentially consists of vessels with the interposition of very little cellular structure; that aneurism by anastomosis is not caused by the production of new vessels, but by an active en-

largement of those which originally existed, attended by a corresponding removal of part of the cellular texture in which they are contained. It does not follow that all the vessels of a part shall be equally enlarged, and this may perhaps account for the difference which has been observed, particularly between these diseases when situated on the scalp, where they most prevail, under the form of aneurism by anastomosis, and when they appear in other parts of the body, as nævi, either congenital or degenerating into the more serious disease.

When the arteries partake most of the disease, the indistinct throbbing attendant upon it is soon perceptible, and becomes in a short time a marked pulsation; but in cases which more frequently occur in children, and are congenital, and the disease seems more to affect the veins, the swelling will be considerable, as in the thumb or hand, lip or nose, the veins greatly dilated, and the part looking varicose without any pulsatory motion being observable. This kind of complaint often remains stationary for years, frequently disappears, and rarely becomes the subject of surgical operation.

The simplest form of nævus, evidently dependent on a peculiar or altered action of the vessels, is where a small red spot like a pin's head is observed, and which is generally on the face, having several red striæ extending from it. This, like many of the purely cutaneous spots or marks, will frequently disappear under the use of the diluted nitric acid; but the best and most certain remedy, whilst it is also the shortest in the time required for the cure, is to raise the skin of the

red spot, and then to touch it steadily with a point of argentum nitratum corresponding to its size. On the separation of the little slough, the ulcer heals, the striæ disappear, and there is scarcely a mark left.

If the nævus be larger, it may be removed by the knife, by the ligature, or by caustic. The latter is however now rarely used in serious cases, and has yielded in slight ones to the application of stimulating remedies, inoculation, &c., which are supposed to be capable of exciting a new action, under which the old one may be removed. The occurrence however of small pox pustules upon nævi of this kind without any permanent good being obtained, leaves little hope of much being done in this way, except in those cases which are of little importance.

Compression and the use of astringent solutions have been recommended by different authors, and it is said that cures have been effected by them. But they are so frequently ineffectual, whilst they always take up so much time, and the compression is so likely to do harm and increase the disease, that I never recommend it; and scarcely ever employ the astringent remedies, unless where the enlargement seems to depend principally upon dilatation of the veins, and that an operation is neither advisable nor necessary.

When a nævus is small, and in such a situation that it can be removed by the knife, it is the shortest and best way of doing it; but care must be taken in making the two elliptical incisions between which it is to be included, that they are in sound parts, and at a little distance from the spot itself; for if they encroach on

it, the hemorrhage will often be alarmingly great from the enlarged and diseased vessels, which appear to have lost their power of contracting; and there will also be a probability of a return of the disease. When the nævus has been dissected out, with a small portion of the sound parts around it in every direction, there will be little bleeding, and the parts will unite by the first intention; but it cannot be too forcibly impressed on the mind of the surgeon, that if the diseased part be cut into, the bleeding will often be terrific and difficult to stop.

If the nævus be large, round, or of a figure which does not admit of its being removed by two elliptical incisions, so as to give a reasonable hope of union; or if the cicatrix resulting from it is likely to be large and unseemly, the operation by ligature is to be preferred, as under such circumstances it often leaves less of a mark or scar.

The ligature is applied in several ways. In order to secure the nævus completely, and to prevent its slipping from within the noose, the needle, which may be either straight or curved, and armed with a double ligature, should be passed underneath it, which will be rendered more easy of execution if the nævus be raised by the fingers of an assistant: care must be taken in passing it underneath, that it goes deeper than the disease. The double ligature being then separated into two parts, one is made to surround one half of the nævus and the second part the remaining portion of the tumour; so that on their being firmly tied with double knots, the circulation shall be completely cut off. After a few days

the nævus drops off under the ulcerative process which is going on below, and if the disease has been completely removed, the ulcer heals without difficulty, and the mark left is often less than if the operation had been done with the knife. If the disease should not have been completely removed, a second ligature must be applied.

This method of proceeding has been followed for many years by the surgeons of the Westminster Hospital: Mr. Lynn, Sir A. Carlisle, Mr. White, and myself. It has been more lately adopted by Mr. Lawrence at St. Bartholomew's; and Mr. Keate, at St. George's, has improved upon it by making use of pins, which, by being passed across but underneath the tumour, admit of compression being made around a larger surface than could conveniently be included in a ligature.

When the disease assumes the character of the more formidable complaint of aneurism by anastomosis, and extends over a considerable space, the operations of dividing the principal vessels leading to the part, of complete excision by the knife, or by ligature, have been resorted to, and also the ligature, under certain circumstances, of the principal trunks at a distance.

The division of the principal arteries leading to an aneurism of this description, and which are accompanied by veins equally dilated, giving to the whole a peculiar and formidable appearance, is rarely attended by success, the circulation being soon re-established by the anastomosing branches, even if it had been inter-

rupted. This operation may however have the effect of depriving the part of a portion of its blood, and will therefore render the excision of the tumour less dangerous. The best case I am acquainted with, in which success attended this mode of operating, is published by Professor Gibson in his Surgical Institutes. The patient, a woman, had a large pulsating tumour, which nearly covered the right side of the head, and often bled profusely. It had existed from infancy, but latterly increased rapidly in size. Dr. Gibson first cut off the supply of blood through the principal arteries supplying the tumour, *viz.* the occipital and temporal. After these operations, the diseased mass was observed to shrink, and the pulsation to diminish; but this relief being only temporary, he proceeded to divide the parts between the former incisions, and to tie the vessels. The first cut was of two inches in extent, and a great deal of blood was lost before all the vessels were secured; the second cut was three inches in length, and was treated in a similar manner; but the patient lost so much blood as to render it necessary to desist from further operation at the time; and some lint was interposed to prevent union of the cut edges. After twelve days a further portion was cut, and treated in a similar manner; and at the end of a fortnight, the remaining part was divided, and the tumour removed, leaving the periosteum untouched, from which granulations soon sprung, and the wound healed in a few weeks afterwards.

The application of a ligature alone has under some

circumstances been found effectual, even in the more formidable cases of aneurism by anastomosis. In one case, the account of which has been published by Mr. Brodie, and in which he could not make use of a common needle and ligature, on account of the size of the swelling, which was on the forehead, he used straight pins like those for the harelip, which being pushed across at right angles enabled him to pass a ligature around the base of the tumour, and thus to cut off the supply of blood to it. In this particular case a second set of pins, and a second ligature, required to be used; but the cure was ultimately complete. It is a mode of treatment precisely similar to that which I have said had been adopted by Mr. Keate in some instances of nævus, and I am disposed to give the preference to it in every case in which the size and situation of the tumour requires such a proceeding.

When this disease takes place within the orbit this method is not practicable, and it is for cases of this kind that the ligature of the carotid has been recommended. This operation, performed on one side, succeeded in the hands of Messrs. Travers, Dalrymple, and Pattison. It has failed of curing the disease, causing only a temporary suspension of it, when tried by Maunoir, Dupuytren, and others. It has even been the cause of death in some instances; and latterly Dr. Mussey, of New Hampshire in America, finding the ligature of one common carotid insufficient, on the tenth day tied the opposite one; but as the case is remarkable, and apparently decisive on this point, I shall transcribe it from the American Journal of the Medical Sciences, for February, 1830.

"J. Pattee, aged twenty years, consulted me in September, 1827, respecting a large pulsating purple tumour, situated upon the vertex of the head, with a base of about five inches in diameter, and rising an inch and a half or two inches above the cranium. This tumour had existed from infancy, but had greatly increased within the last three years. Upon the apex of the tumour was a sluggish ulcer of an inch in diameter, which commenced two years before, had been slowly enlarging, and which had bled occasionally during the preceding spring and summer, and once to the amount of two quarts, as estimated by his physician. The left temporal artery and vein, where they pass in front of the ear, presented through the integuments the appearance of a vessel five-eighths of an inch in diameter. This was so prominent in its winding course along the temple, and even to the base of the tumour, that its pulsations could be distinctly seen at the distance of fifteen feet. A vein which passed from the tumour down the forehead, was full and prominent, and half an inch in diameter; and when the head was shaved, more than twenty arteries running to the tumour were seen actively pulsating, none of which, as they appeared through the integuments, were less than a middling-sized goose quill. Curious to know what would be the effect of securing the large arteries, from which branches were distributed to the tumour, I tied on the 20th of September the left primitive carotid. The tumour after the operation was a little less tense, and less livid; still the active pulsation of the numerous arteries upon the right side of the base of the tumour, rendered it evident that there was

an adequate supply of blood. On the twelfth day from the operation, I tied the right primitive carotid artery. The face was a good deal paler immediately after this operation, but what was scarcely to have been expected, the functions of the brain were not apparently disturbed. There was neither nausea nor faintness; the patient rose from the table, stood up, and while standing put on his vest and coat, and tied on his cravat; he then walked down two flights of stairs, got into a carriage, and rode to a distant part of the village, without feeling the least symptom of faintness, or manifesting signs of inconvenience. The tumour, which after this operation was daily dressed with a compress and bandage, so as to make slight compression upon it, the compress being kept constantly moist with alum water, progressively subsided, and in about four weeks was reduced apparently to about one-third of its original volume. At this period the tumour became stationary, and in five or six days began very slightly to enlarge; its colour was a little deepened, and a feeble thrill, corresponding with the pulse in other parts, could occasionally be perceived in the left temporal artery. These appearances indicating that nothing further was to be expected from the tying of the carotid, astringent applications, and compression, I proceeded, on the 22d of November, about six weeks from the second operation, to remove the tumour. This was accomplished by first encircling the tumour by an incision made quite through the soft parts, and then rapidly dissecting away the whole mass from the pericranium. More than an hour

was occupied in carrying the knife around the base of the tumour, the whole operation being conducted with immediate reference to the saving of blood. Not more than an inch and a half of the scalp was divided at a time, and immediately upon the division, firm compression was made upon each lip of the incision, while the vessels were secured by ligatures, more than forty of which were applied in going round the tumour. Notwithstanding however these precautions, it was estimated by all present, that blood to the amount nearly of two quarts was lost during the operation. The patient was faint, and continued very feeble for several hours. The naked pericranium, in extent equal to about twenty-five square inches, granulated kindly, and in eight weeks the wound was nearly healed. It was some months, however, before the cuticle, through its whole extent, became firm, so as to sustain itself under considerable variations in the state of the circulation. The patient returned to active labour upon a farm the following March or April, has continued it ever since, and has been one of the most athletic and industrious labourers I have ever seen."

It will be seen from these observations, that there are several modes of proceeding in cases of aneurism by anastomosis. I have never met with or operated upon a case of that size, or in that situation, which did not admit of the application of a ligature by one of the means I have noticed; and I suspect, that in most instances the ligature may be applied with the best effect, in the earlier states of the disease, be-

fore it has attained too great a magnitude to be treated in that manner. The size of these tumours is often more apparent than real, the varicose veins leading from them adding much to their dimensions. It is however only the generally pulsating part which constitutes the real disease, and the extirpation of which is attended by danger; the enlarged arteries and veins, leading to and from it, recovering their former size after the diseased part has been removed.

OPERATIONS.

On the Aorta.

It is stated by Desault, in the Journal de Chirurgie, that M. Paris, in the year 1789, injected the body of an old woman with equal parts of suet and resin coloured with lamp black; and observing the thoracic arteries to be remarkably enlarged on the sides of the chest, he examined the arterial system with attention. The aorta was found contracted to the size of a writing quill, immediately beyond its arch. Above the constriction it was very slightly dilated, below it was of its natural size, and the coats of the artery were of their proper thickness. The carotids were natural. The arteria innominata and left subclavian were enlarged to twice their natural diameter, and all their smaller branches had increased in the same proportion. The internal mammary and phrenic arteries were greatly enlarged, and very tortuous. The transverse arteries of the neck were twice their natural size; their posterior branches were tortuous, extending to a great distance over the back, with long inosculations, which were met from below by the branches of the upper intercostal arteries, which were also remarkably enlarged. The thoracic and scapular arteries, which go along the sides of the chest, were of twice their usual size. Below the constriction, the lower inter-

costals were increased even to three or four times their natural size; each of them was dilated, but those were most so which came off highest and nearest to the contracted parts; the posterior branch of each, which penetrates to the muscles of the back, was more dilated than that which runs betwixt the ribs, and the inosculations of those posterior branches with the branches of the transversalis cervicis were very striking. The lower phrenic artery was enlarged and inosculated with the superior phrenic. The epigastric was dilated to the size of the enlarged mammary, and was joined with it by very numerous and very conspicuous anastomosing branches.

Dr. Graham of Glasgow met with a case of obstructed aorta in a lad fourteen years of age, who died of an affection of the chest, in whom the complaint was not suspected.

"The aorta expanded unusually near its origin, so as to form a kind of pouch; but after giving off the branches to the head and superior extremities, its diameter was preternaturally contracted. It was continued of this diminished size till after its union with the canalis arteriosus, where it was completely impervious. The coats were not thickened, nor in any way diseased, except that about half an inch below the stricture there was a smooth elevation on the inner surface, less raised, but having nearly the diameter of a split pea, otherwise the appearance was exactly such as if a ligature had been tied tightly round the artery. It is faithfully represented in the drawings. The ob-

struction was about a line in breadth. The artery there received three trunks about the size of crow quills, and near them three smaller ones, afterwards resuming its natural size along the vertebræ. These three trunks are evidently the uppermost of the inferior intercostals; their coats were remarkably thin, like those of veins. A probe passed from the pulmonary artery along the canalis arteriosus to the obstructed portion of the aorta, but from its thickened appearance it did not seem probable much communication by means of it could have been allowed, and the florid countenance of the boy during life establishes the same conclusion. There having been no suspicion of this singular deviation from the natural structure till after the contents of the thorax were removed from the body, it was impossible to trace with the accuracy that could be wished the anastomosing branches by which the circulation had been carried on in the inferior parts of the body; but I think enough has been observed to lead us very near the truth. The arteria innominata, the left subclavian, the superior intercostals, and the mammary arteries were much enlarged. The epigastric was reported of its natural size. These facts, and the aorta acquiring at least very nearly its natural size immediately below the stricture, show that the blood did not pass to the inferior extremities in any material quantity, as might perhaps have been expected, by the inosculations of the mammary and epigastric arteries; but chiefly by the communications of the superior intercostals and the mammary arteries with the three large branches

entering the aorta below the stricture; also from the mammaries and thoracics through others of the intercostal and diaphragmatic arteries."

In the two preceding cases of obstructed aorta, the coats of the artery were in their natural state; in the two following they were much thickened.

Dr. Goodison's own description is as follows:—

"I found the aorta to be obliterated from the origin of the inferior mesenteric artery downwards for the remainder of its length, together with the greater part of the iliacs on each side, the cavity of that on the left side being obliterated to its bifurcation into external and internal, and that on the right to more than one-half of the length of the common iliac.

"The artery lay close and was firmly attached to the spine. It had precisely the appearance of the trachea, being rendered flat upon its posterior surface, but preserving anteriorly its circular or convex form.

"The iliac veins were so intimately connected with the arteries, as to cause considerable difficulty in their removal.

"There was a large quantity of gelatino-cartilaginous matter surrounding that part of the aorta and vena cava, together with the portions of the iliac arteries and veins which were included in the disease.

"The external appearance of the artery at first led me to think that an enlargement of its cavity existed; but this was not the case at the time of the examination, whatever might have been its state formerly. This appearance was owing to the formation of the

case of bone externally, and to the formation of gelatino-cartilaginous matter internally.

"The bony sheath encased the artery for the space of about two inches, and was filled with a firm fleshy substance, which had the appearance of the muscular fibre of the heart. The substance was prolonged upwards beyond the bony sheath, and adhered firmly to the coat of the artery.

"The coats of the artery at the diseased part were separated, and the internal coat having become the medium for the deposition of the ossific matter, had been literally converted into bone."

Mr. Crampton observes, "By cutting longitudinally through the diseased portion of the artery, and turning out the condensed coagulum with which it was filled, I was enabled to ascertain the real nature of the changes which the vessel had undergone previous to its obliteration.

"The internal coat, covered with steatomatous and earthy concretions, completely lined the cavity of the dilated portion of the artery; the dilatation itself consists of three irregular pouches, which proceeded from the anterior and lateral surface of the vessel. It is obvious, therefore, that the disease commenced with dilatation of the artery, in consequence of a previously diseased and weakened state of its coats; that the coats had suffered neither ulceration nor rupture was evident, since, when the coagulum was detached, the internal membrane was found smooth and unbroken, and its surface presented precisely the same diseased appearances which were found on the internal coat of

the aorta, immediately above and below the dilatation."

The following case is by Dr. A. Monro, who says, in his Observations on Aneurism of the Abdominal Aorta, page 5, "Upon turning over the convolutions of the smaller intestines, a distinctly circumscribed tumour, rather more than three inches in breadth and about two inches and three quarters in height, was observed lying upon the second and third lumbar vertebræ, which upon a more minute investigation proved to be connected with the descending abdominal aorta. This tumour was considerably flattened, and adhered very firmly to the second and third lumbar vertebræ, which were partially absorbed; and, when compressed, it felt somewhat hard, and evidently was filled by a quantity of clotted blood. Upon cutting through the sac, it was found to be much thicker than the coats of any sound artery; and it did not seem to be composed of distinct layers, nor was there any deposition of bone in any part of it, and in appearance it very much resembled thick white leather, which had been steeped for a considerable time in water.

"The abdominal aorta entered into the very middle of the sac, which was situated at the division of the aorta into the two great iliac arteries; and I am disposed to think that it was formed by the uniform expansion of the coats of that artery; and their unnatural thickness was probably owing to the addition of a quantity of compact cellular substance.

"The aneurismal tumour was filled by portions of coagulable lymph, which were not disposed in parallel

layers of an equal thickness, as in the greater number of aneurisms, but of short and unconnected portions of coagulable lymph, which crossed each other in different directions, so as to form a confused and irregular mass, which, on being pressed between the fingers, was evidently mixed with a gritty substance like sand.

"After the removal of the sac, I carefully examined its inner surface, but could not discover any appearance of a rupture of the inner coats of the aorta.

"The cœliac, superior mesenteric, renal, inferior mesenteric, and lumbar arteries, were not larger than usual. A very correct idea as to the size of the intercostal and epigastric arteries could not be formed, as they had been divided in cutting through the parietes of the abdomen.

"The portion of the artery which is immediately above the aneurismal tumour is evidently contracted, and was impervious; and in that place the coats of the artery were to the touch firmer, and also whiter than usual. Above this contracted portion, a conical-shaped plug, of a firm nature, was placed, with the smaller extremity undermost. This plug was of a deep red colour, and seemed to be composed of a solid mass of coagulable lymph, intermixed with the red globules of blood. It was an inch and one-eighth long, about an inch broad at its basis, and was fixed by thin laminæ of coagulated lymph to the sides of the aorta.

"This mass of coagulable lymph filled and completely obstructed the passage of the blood through the aorta.

"As this plug adhered intimately to each side of the vessel by thin and dense layers of coagulable lymph, it appears to me that it was not formed *in articulo mortis*, but some time before death, and probably by an inflammatory action of the vasa vasorum of the coats of the aorta.

"From the vicinity of the aneurismal tumour to the lumbar vertebræ, the vessels proper to these bones must have been much irritated; but they did not, as in the greater number of instances in which an aneurism is seated in the immediate vicinity of a bone, secrete bony matter. A considerable portion of the second and third lumbar vertebræ was absorbed.

"The case which fell under my notice, affords a striking example of the circulation being carried on, when none of the blood reached the contents of the pelvis or the inferior extremities by the medium of the trunk of the aorta; and also, that the blood may be diverted from its usual channel without a derangement of the functions of that part of the body which is usually supplied by the aorta.

"The blood probably reached the pelvis and inferior extremities of the body by different channels; a part of it by the anastomosis between the internal mammary and epigastric artery; another part of it by the medium of the anastomosis between the phrenic, lumbar, ileo-lumbar, and circumflex arteries, and by the anastomosis between the ascending branches of the gluteal and lumbar arteries; and I conceive that but a small part of the blood found its way downwards by the anastomosis between the internal mammary and epigastric arteries; as there must be a considerable impediment to the free flow of blood by that channel, for the usual

current of the blood is then reversed; for instead of the blood rising upwards toward the internal mammary artery, as in the natural circulation, it must have descended through the epigastic artery towards the inferior extremities, by which the natural course of the blood is reversed."

The preceding cases prove, that the obliteration of the canal of the aorta, at any one part, is not incompatible with the continuance of life; and there are cases in which it is supposed that this obliteration, if it could be accomplished by the application of a ligature, might be the means of saving life. It has been attempted twice, by Sir Astley Cooper, and by Mr. James of Exeter. The first case was one of iliac aneurism of great size, which sloughed, and the patient nearly bled to death. Sir Astley Cooper, in order to avoid opening the abdomen to secure the aorta near to its bifurcation, made an incision into the aneurismal sac above Poupart's ligament, to ascertain if it were practicable to pass a ligature around the artery from thence. Finding that this could not be accomplished, he proceeded to tie the aorta, by making an incision three inches long into the linea alba, avoiding the umbilicus by a curve in the incision; having opened the peritoneum, he enlarged the wound, and pressing his finger between the convolutions of the intestines down to the spine, he felt the aorta beating against it. He then scratched through the peritoneum, covering it with the nail of his fore finger, and gradually passed it under the artery, and again penetrated the peritoneum on the right side of the aorta; a blunt aneurismal needle armed with a single ligature was passed by the side of

the finger, and care being taken to exclude the intestine, it was drawn tight. The patient survived the operation forty hours, dying exhausted.

Mr. James of Exeter tied the aorta on the 5th of July, 1829, in a case of aneurism of the external iliac artery, nearly in the same situation, and by a similar operation to that performed by Sir Astley Cooper; the patient died the same evening, having suffered extreme pain in the aneurismal limb from the time the ligature was drawn. He had previously applied a ligature on the femoral artery below the tumour, on the 2d of June, which was at first followed by a very sensible decrease in the swelling; but shortly after it began to enlarge considerably, and as sloughing seemed to be impending, the operation on the aorta was had recourse to. Dissection showed that the external iliac divided into two nearly equal trunks, to which the failure of the first operation is attributed. It is possible that this case may bear in an important manner on the arguments for or against the principle of the operation, as performed below or beyond an aneurism; but as the details are not published, I have not taken the case into consideration when noticing this peculiar subject.

Sir Astley Cooper has said, that if a case like that above described should again occur to him, he would seek the aorta behind the peritoneum as in the operation for placing a ligature on the common trunk of, or on the internal iliac artery; and there can be no doubt but that the common iliac and even the aorta may be always got at nearly as easily in this manner, as the internal iliac. If there is reason to believe that the

aneurism extends higher than the common iliac, an operation should not be attempted; for although the aorta may become obliterated through inflammation, I do not think it is likely to be so by a ligature applied upon it either above or below an aneurism; and no one has hitherto been so hardy as to propose it, or the ligature of the common iliacs for the cure of aneurism of the abdominal aorta.

Of the Operation of placing a Ligature on the Aorta, on the Common Trunk of the Iliac, and on the Internal Iliac Artery.

A ligature has been successfully placed on the internal iliac artery, in a case of gluteal aneurism, by Dr. Stevens, who has given an account of the case in the fifth volume of the Medical and Chirurgical Transactions. It has certainly been done in three other instances; one of which, in Russia, is stated to have also been successful; the other, by Mr. Atkinson, of York, failed. The third by Dr. White succeeded.

The patient, sixty years of age, had a tumour of the size of a child's head, directly over the sciatic notch, of ten months' standing, but without pain. His health was good. The skin not discoloured. Fluctuation perceptible, but not pulsation. In the absence of this symptom, the tumour was punctured, and nothing made its appearance but florid blood; a probe was passed in to the depth of five inches, and after about a pint of blood had been lost, the orifice was closed with a suture and adhesive plaster. It was observed

that after this, and also subsequent discharges of blood, the sac would fill again, and the tumour resume its usual dimensions. After several profuse hemorrhages, the patient agreed to submit to an operation, and the internal iliac was accordingly tied. Some pain in the bowels and fever came on a few days after the operation, which were removed by venesection and a laxative. Union by the first intention had taken place to a considerable extent at the first dressing on the eighth day. A considerable quantity of pus was discharged during the first four weeks, at the expiration of which time the ligature came away. The tumour discharged its contents gradually, and the parts have assumed their natural appearance.

The common trunk of the iliac has been once included in a ligature by Professor Gibson, of Pennsylvania, and once by Professor Mott, of New York; both were unsuccessful.

The following is an abstract of Dr. Gibson's case.

"During the riots in Baltimore, in the year 1812, a man received a wound from a musket ball; as the accident occurred near to where professor Gibson was standing, he promptly examined the wound, which he found bleeding with great profuseness. He thrust his finger into the wound, and with it compressed the bleeding vessel, until the patient was carried home. From the direction of the wound, he supposed the injured artery to be the common iliac near its bifurcation. Though the patient was much exhausted by the hemorrhage, yet he determined to make an effort to save him by securing the artery. The integuments of the abdomen above and below the wound were divided. The peri-

toneum was next cut through, the intestines were turned to one side, until the artery was exposed and slightly detached from the parts in its immediate vicinity. Ligatures were now applied around the left common iliac artery above and below its division. He next turned his attention to the intestines, which were opened in two convolutions. The apertures in the intestines were drawn together by a fine ligature, upon the plan suggested by Sir Astley Cooper. The clotted blood was removed from the abdomen, and the external wound closed. As might be expected, coldness of the left limb followed the injury and the operation; but the following day the temperature increased, and continued to increase until it rose to nearly the heat of the opposite leg.

"On the fourth day, symptoms of peritoneal inflammation supervened.

"On the ninth day, the patient was seized with secondary hemorrhage, which at intervals continued until the thirteenth day, when he expired.

"On opening the abdomen after death, the folds of the intestines were united to each other in every direction by inflammation. The upper ligature was found detached from the vessel, which projected and preserved the circle of its mouth entire. No union whatever had taken place between the sides of the artery. The impaired vitality of its coats, arising from contusion, was sufficient to prevent their union by adhesive inflammation. The bullet was found imbedded in the upper part of the sacrum."

Abstract of Dr. Mott's case.

The tumour was of large size, protruding the

belly considerably at the iliac region; the patient suffered most excruciating pain, which appeared to increase as the tumour enlarged. Dr. Mott's incision extended from the external abdominal ring to one or two inches above the crest of the ilium, dividing the tendon of the external oblique, and cutting through part of the origins of the internal oblique and transversalis. He then cautiously raised the peritoneum with his fingers, and succeeded in detaching it entirely from the tumour and vessels, without doing it the slightest injury. The artery was then examined, and the aneurismal dilatation was found to cease at about half the distance between the bifurcation of the aorta and the origin of the internal iliac branch. The ligature was passed from the outside of the vessel by the aid of the excellent instrument devised by Drs. Parrish and Hewson, carefully avoiding the iliac vein.

"The protrusion of the intestines rendered this part of the operation the most difficult. After the ligature was passed around the vessel, the wound was held open in such a manner as to allow the medical gentlemen present to see, and satisfy themselves of the exact situation of the ligature, which was just below the bifurcation of the aorta into the primitive iliacs, and on the side of the sacro-vertebral promontory. The ligature was then drawn tight and secured; the pulsation of the tumour ceased, its size was much diminished, and the patient was relieved from agonizing pain, previously unremitting.

"The wound was lightly dressed, and the patient put to bed; the limb of the side operated on was cold, as might be anticipated; it was wrapped in cotton, and

covered up to preserve the temperature until the circulation should be restored. To the great surprise and satisfaction of the surgeon, in a little more than half an hour after the operation, the circulation and temperature were entirely restored, and all fear respecting the supply of blood to the limb effectually dissipated.

"No untoward circumstance occurred after the performance of the operation. The patient complained of no inconvenience, except a peculiar sensation of fulness or tension in the limb, as if the small vessels had not yet become accustomed to their new office in sustaining the great mass of the circulation for the support of the member."

In performing either of the three operations, it is advisable to compute the point at which the artery is to be tied, with relation to the umbilicus and the anterior superior spinous process, and the crest of the ilium. The aorta bifurcates usually on the body of the fourth, or on the intervertebral substance between it and the fifth vertebra, although it may be higher or lower, which cannot be ascertained previously to the operation; and the most usual place is nearly opposite to the margin of the umbilicus on the left side. It is about half an inch above this that the ligature should be placed on the aorta, and rather lower than higher, on account of the origin of the inferior mesenteric artery. As this artery is to be reached by carrying the finger along the common iliac, the comparative situation of that vessel is next to be estimated.

The aorta divides into the two common iliac arteries, the length of which varies according to the

stature of the patient, and the place at which the aorta bifurcates. The common iliacs again divide into external and internal iliacs, which division is usually opposite to the sacro-iliac symphysis. The length of the common iliac artery is therefore tolerably well defined, as scarcely ever exceeding two inches and three quarters, and seldom being shorter than two inches. The external iliac is a little longer than the common iliac, and the place of subdivision of the common iliac into external and internal can always be ascertained during an operation, by tracing the external iliac upwards to the junction of it and the internal one to form the common trunk, which proceeds upwards and inwards to the aorta. The left margin of the umbilicus being taken as a point opposite to that which may be presumed to be the part at which the aorta divides, and the situation of the external iliac becoming femoral being clearly ascertained, a line drawn between the two will nearly indicate the course of these vessels; sufficiently so at all events to enable the operator to mark with his eye the place where he expects to tie the artery, and to regulate the length of the incision, so that this ideal spot may correspond to the centre of it. It is necessary to recollect also, that the whole of one hand and part of the other must be introduced into the wound, to enable the operator to pass the ligature around the artery, and to tie the knots; so that an external incision of less extent than four inches will not suffice, and five will afford a facility in operating, which will save pain to the patient, and inconvenience to the operator. In calculating the length of the incision, allowance must also be made for the size, corpulence,

and muscularity of the patient. If a rule be placed on the crest of each ilium, about one inch and a half behind the anterior superior spinous process, it will pass in a well-formed man across the junction of the fifth lumbar vertebra with the upper part of the sacrum, and a little way behind where the common iliac divides into external and internal. The centre of an incision, five inches in length, beginning about half an inch above Poupart's ligament and about the same distance to the outside of the inner ring, and carried upwards, will fall nearly on a line with this point. The incision should be nearly parallel to the course of the epigastric artery, but a little more to the outside, in order to avoid it and the spermatic chord, and having a gradual inclination inwards towards the external edge of the rectus muscle, the patient being on his back, with the head and shoulders raised, and the legs bent on the trunk. The aponeurosis of the external oblique muscle being opened inferiorly, it is to be slit up for the whole length of the external incision; and the director being first passed under the internal oblique muscle, through a small opening carefully made into it, it is to be divided in a similar manner. The transversalis is then to be cut through at the under part, and its tendinous expansion divided at the upper part, the greatest precaution being taken by the finger to prevent the peritoneum from being injured. The fascia transversalis is then to be torn through at the lower and outer part, so that the fingers may be passed outwards towards the ilium, and the peritoneum detached from the iliac fossa, and turned with its con-

tents inwards, by a gradual and sidelong movement of the fore and second finger, inwards and upwards, until passing over the psoas muscle the external iliac artery is discovered by its pulsation. It is then to be traced upwards and inwards towards the spine, when the origin of it and the internal iliac from the common iliac trunk will be felt. The point of the fore finger will then be nearly in the centre of a line drawn from the umbilicus to the anterior superior spine of the ilium; and hence the necessity for an incision of five inches in length, if the artery is to be tied high up, which is to be accomplished by tracing it in a similar manner to its origin from the aorta. If the *internal iliac* is to be tied, the operator traces it downwards from its origin, rather than passes his finger from the external iliac artery inwards in search of it. Having placed the point of his fore finger on the vessel at the part where he intends to pass his ligature, he scratches with the nail upon and on each side of it, so as to separate it from its cellular attachments, and from the vein which accompanies but lies behind it. Thus far the operator proceeds by feeling; but it is now necessary that the sides of the wound should be separated, and kept apart by blunt spatulæ curved at the ends, so as take up as little space as possible, and not injure the peritoneum. The surgeon should if possible see the artery, and the ligature carried on the eye of a bent probe, or a convenient aneurismal needle, should be passed under it from within outwards, when it should be taken hold of with the forceps; the probe or needle should then be withdrawn, and the ligature firmly

tied twice, or with a double knot. Great care must be taken to avoid every thing but the artery. The peritoneum which covers it, and the ureter which crosses it, must be particularly kept in mind. The situation of the external iliac artery and vein, which have been crossed to reach it, must be always recollected, and if there be sufficient space they should be kept out of the way, and guarded by the finger of an assistant.

The *common trunk* of the iliac arteries and the aorta itself may be tied by the same method of proceeding; the only difference which can be practised with advantage will be to make the incision longer at its upper part; no inconvenience arising from the addition to the length of the external wound, whilst the subsequent steps of the operation are much facilitated by it. It is only when the upper part of the common iliac or the aorta is to be tied that the incision will require to be lengthened to six inches; the superior extremity of it being already on a line with the junction of the third and fourth lumbar vertebræ. By passing the finger under the peritoneum, along the common iliac, it will rest upon the aorta, which may have a ligature placed upon it in this manner; and if the operation shall ever succeed, I have little doubt but it will be done in this way. There is an impression however on my mind, that the ligature of the aorta may in almost every instance be superseded by that of the common iliac artery, for although I have entered fully into the history of those cases in which the aorta has been found obliterated, I cannot but feel most forcibly the difference between the gradual formation of an obstruction, and

the sudden application of a ligature. The tying of the common iliac half or three quarters of an inch below its origin, will I suspect be sufficient to save the life of every patient, whose life is to be saved by an operation of this nature. The situation of the ureter and rectum on the left side, and the ureter and the cœcum with its appendix on the right side, must be well understood, and the greatest care should be taken to avoid injuring the peritoneum; not that I consider a wound of that part so necessarily fatal, or even as dangerous as it is usually supposed. The relative situation of the common iliac artery and vein should be particularly attended to in passing the ligature around the vessel. On the left side the artery lies external and anterior to its accompanying vein. On the right it passes over the commencement of the vena cava and the left iliac vein. These operations must always be more difficult on corpulent persons, or those whose bowels are naturally enlarged or full, and the necessity for freely evacuating them, by purgatives if possible, as well as by injections if there is not time to wait the effect of purgatives, is so obvious, that it need not be further noticed. Purgatives should not be given after the operation. The food should all be liquid, and inflammation should be subdued by leeches, general bleeding, fomentations, and opium.

The *external iliac* artery has been so often and so successfully tied, that a description of the two methods of proceeding commonly adopted will suffice. The first, recommended by Mr. Abernethy, is in accordance with the operations on the common and on the internal iliac. The patient being laid on his back, with the

shoulders slightly raised, and the legs bent on the trunk, an incision is to be made about three inches and a half in length in the direction of the artery, and terminating over or a little above Poupart's ligament. The aponeurosis of the external oblique muscle will be exposed, and an opening being made into it, a director is to be introduced, and it is to be slit up to the extent of the external incision. The internal oblique and transversalis muscles, which are closely connected with each other, are to be carefully cut into at the lower part, so as to allow a director or the point of the finger to be introduced below them, when they also are to be divided, the finger separating them from the fascia transversalis and peritoneum. The fascia transversalis running from Poupart's ligament to the peritoneum is now to be torn through with the nail, immediately over the pulsating artery, and the peritoneum is to be separated by the finger and pushed upwards until sufficient room is obtained; which, in this as well as in all other operations on the iliac arteries, is sometimes difficult on account of the protrusion of the intestines covered by the peritoneum, when the patient is not sufficiently tranquil. The artery is yet at some depth, and covered by a dense cellular membrane, connecting it to the vein on its inside, and which must be torn through with the nail. The anterior crural nerve is separated from the artery by the psoas muscle, at the outer edge of which it lies. The aneurismal needle should be passed between the vein and the artery, and the point be made to appear on the outside of the artery.

In this operation the ligature is placed on the external

iliac, above where it gives off the epigastric and circumflexa ilii arteries; and as the operation is very much the same as those before described, with the exception of the incision being shorter and nearer to Poupart's ligament; it is obvious that if it were found necessary from disease to tie the artery higher up, or even to tie the common iliac, that it might be done by merely enlarging the wound.

Another method has been recommended by Sir Astley Cooper, which is perhaps more followed where there is little doubt of the artery being sound. It offers the advantage of greater space, which enables the surgeon to see better what he is doing; but it does not so readily admit of the artery being tied high up, without an additional incision being made in a direction different from the first, which is after all a matter of no consequence, if it were found necessary to do it.

The patient being placed in the recumbent posture, on a table of convenient height, the incision is begun just above the abdominal ring, and is extended downwards in a semicircular direction to the upper edge of Poupart's ligament, and again upwards, to within an inch of the anterior and superior spinous process of the ilium. This incision exposes the tendon of the external oblique muscle: in the same direction the above tendon is to be cut through, and the lower edges of the internal oblique and transversalis abdominis muscles are exposed; the centre of these muscles is then to be raised from Poupart's ligament; the opening by which the spermatic chord quits the abdomen is thus exposed, and the finger passed through this space is

directly applied upon the iliac artery, above the origin of the epigastric and circumflex ilii arteries. The iliac artery is placed upon the outer side of the vein; and the next step of the operation consists in gently separating the vein from the artery by the extremity of a director, or by the end of the finger. The iron curved aneurismal needle is then passed under the artery, and between it and the vein from without inwards, carrying a ligature, which being brought out at the wound, the needle is withdrawn, and the ligature is then tied around the artery, as in the operation for popliteal aneurism. One end of the ligature being cut away, the other is suspended from the wound, the edges of which are brought together by adhesive plaster, and the wound is treated as any other containing a ligature."

I have seen the epigastric artery divided in this operation, and two ligatures placed upon it without any inconvenience occurring; and I have reason to know, that this artery is made a greater bugbear of than there is any occasion for in all operations on these parts. If the surgeon has unluckily divided it, either in this or in any other operation, all that he has to do is to enlarge the incision, and tie both the divided ends; and I have no hesitation in saying, it will not be of any consequence, either in this operation or in one for hernia. If a man has been so unfortunate as to have a wound in his peritoneum of a quarter or of half an inch in extent, two ligatures on the epigastric artery, and a slight increase in the extent of the external incisions, add little or nothing to the danger;

which only takes place in reality when the wound is closed up, and the artery is allowed to bleed internally.

Of placing a Ligature on the Gluteal and Sciatic Arteries.

In all cases of aneurism of the gluteal and sciatic arteries, the internal iliac artery should be tied, instead of an operation on the part itself. In all cases of wounds, which are the only ones rendering an operation for placing a ligature on these arteries necessary, the wound should in a great measure regulate the course of the incision. The operation is an act of simple dissection, first, through the common integuments for the space of four inches, then through and between the fibres of the glutæus muscle to the same extent; a dense aponeurosis covering the vessels is to be next divided, when the bleeding will lead to the injured vessel. In the dissecting room the operation is described as follows: Place the body on the face, turn the toes inwards; commence the incision one inch below the posterior spinous process, and one inch from the sacrum, carry it on towards the great trochanter in an oblique direction to the extent of four inches, divide the glutæus muscles and the aponeurosis beneath it, and seek for the artery as it escapes through the upper and anterior part of the sciatic notch and lying close to the bone. If the vessels of the glutæus muscle bleed, so as to be troublesome, and cannot be stopped by compression, they must be secured.

If the sciatic artery be the vessel injured, the incision should be made in the same direction, but about an inch and a half lower down; if the course of the wound renders it doubtful which artery is wounded, the incision should be as nearly as possible between the two lines directed, the wound being always the best guide; and care should be taken in every instance to include nothing in the ligature but the artery.

Operations on the Femoral Artery.

The whole length of the femoral artery, from where it passes under Poupart's ligament, until it reaches the tendon of the triceps, is often the seat of surgical operation, and it may be required to place a ligature around any part of it in this course. There are two places at which it is most frequently required to be done: near the crural arch, in consequence of femoral aneurism; and lower down, where the operation is performed for popliteal aneurism.

As this is the first artery noticed, on which it is possible to make compression with effect, it is proper to remark, that it should never be made on an artery on which a ligature is about to be placed; because the pulsation is thereby suppressed, and the most important guide to the vessel is at the same time taken away. Where the artery is wounded and bleeding, compression must be had recourse to in the first instance to arrest it; and the first incisions must be made without the information which the pulsation gives as to the precise situation of the artery, although

the finger may be allowed to rest on the part, underneath which the artery could be felt before the pressure was applied. The external incision should always be made longer or shorter in proportion to the depth at which the artery is situated. It should be at least one-third longer in the middle than at the upper part of the thigh; and whilst a long incision always facilitates the subsequent steps of the operation, it never does harm, unless it be out of all reasonable proportion. The centre of the incision should be if possible directly over that part of the artery on which it is intended to apply the ligature; but no inconvenience will arise from its being applied nearer the upper extremity of it. The patient being laid on his back, and properly supported, the knee is to be bent and turned outwards, by which the head of the femur will be rolled in the acetabulum, and the femoral artery will be more distinctly felt at the upper part lying on the psoas muscle; having the vein to the inside of it, and the anterior crural nerve about half an inch on its outside, passing between the psoas and iliacus muscles, although some branches soon approach the artery, and run down on the external part of the sheath. The relative position of the parts being duly considered, an incision is to be made directly in a line over the pulsating artery, and carried through the skin, cellular tissue, and superficial fascia, down to the deep-seated, or fascia lata of the thigh. If an absorbent gland should be in the way, it must be turned aside or removed. The arteria profunda femoris is given off about two inches below Poupart's ligament, on the back part and outside,

whilst three or four small vessels spring from half an inch to an inch below it on the fore part, and one or other of these may be divided. They are the superficial epigastric, the superficial pudic, the superficial circumflex of the ilium, and probably an artery supplying the absorbent glands. If they bleed so as to be troublesome they must be secured, more particularly if the femoral artery is to be tied below them. The fascia lata is now to be divided, with that part of the fascia transversalis, which descending beneath Poupart's ligament forms the sheath of the artery, when the vessel will be exposed. In dividing this fascia and sheath, the point of the knife is always to be directed to the centre of the artery, so that if it be cut by accident it may be seen, when the only result will be the necessity for the application of a ligature above, and one below it. The artery being fully exposed, as ascertained by the pulsation being felt by the finger, it is to be separated from its cellular attachment to the sheath on each side by a blunt or silver knife; and the aneurismal needle or probe, armed with a strong single thread of densist's silk, is to be passed under it from the in or pubic side outwards, by which all injury to the vein from the round point of the needle or probe will be avoided. Two common knots are to be made in the usual manner, when one thread may be cut off, or the two twisted together and brought carefully out of the wound; the edges of which are then to be duly approximated and retained in that situation by sticking plaster and a moderate compress, also secured in

a similar manner. The knee is to be bent forward to relax the parts, and laid on the outside with a pillow underneath it.

The needle will pass more easily under the artery if the thigh is bent on the trunk; and before the knots are tied, the surgeon should ascertain that pressure on the part or artery which he has nearly surrounded by the ligature, suppresses the pulsation in the tumour below.

The operation for popliteal aneurism lower down in the thigh is to be done in the following manner.

The surgeon having turned the knee outwards, and bent the leg inwards into the tailor's sitting position, to show the course of the sartorius muscle, should trace the artery from the groin downwards, until it appears to pass under that muscle. The external incision, four inches in length, made in the course of the artery, should pass over this point one inch, so that when the fascia lata is divided, the sartorius muscle may be seen crossing over to the inside at the lower extremity of the wound. The fascia lata is to be divided for the space of two inches of the incision upwards. The fore-finger is then to be introduced into the wound, and pressure made with it rather outwardly, when it will readily distinguish the pulsation of the artery, still included in its sheath. This is to be opened by slight and repeated touches of the knife directly over the centre of the line of the vessel, or it may be divided on the director, when the artery will be exposed. The point of the fore finger will easily recognize it from the roundness and firmness of the feeling communicated by it as well as by its pulsation, and the

end of the nail, or handle of the scalpel or blunt knife, will separate it with facility from its attachments, to such an extent as will admit the blunt point of the solid unyielding aneurism needle to be passed beneath it from the pubic side. If the point of the needle does not readily come through the cellular attachments of the artery on the outside, this part must be touched lightly with the scalpel, or rubbed with the nail until the ligature is exposed, which should then be taken hold of with the forceps and one end drawn out, whilst the instrument with the other end is withdrawn. The operator, taking both ends of the ligature, which has been in this manner passed under the artery, between the fingers of one hand, presses upon the artery with the fore-finger of the other, so as to arrest the course of the blood in it, when if there be an aneurism below, the pulsation in it will cease. The ligature is then to be pressed upwards as far the artery has been detached, and is to be tied with a double knot. The wound is to be dressed as in the previous case by sticking plaster and compress, but without a bandage; and the patient is to be placed in bed, with his knee bent forward, or resting on the outside if more agreeable to him.

The operation is done in this manner on that part of the femoral artery which is not covered by muscle, and all interference with the sartorius is avoided. It is the improvement on the Hunterian operation recommended by Scarpa, and ought always to be adopted. This method obviates all discussion as to placing the ligature on the outside of the sartorius muscle, or as to the fear of injuring the absorbents; and as to the sa-

phena vein, it can always be seen and its course traced up the thigh and avoided. After the first incision is made and completed down to the fascia lata, that part is to be divided, I have said for the length of two inches, but this must be dependent on circumstances; the object being to obtain a view of the sheath containing the artery, the opening into which after the first touch of the knife may be completed with the assistance of the director underneath it; and the artery will be less disturbed in its lateral attachments by an opening into the sheath of three quarters or an inch in length, than by one of half the extent, as it will admit of the aneurism needle being passed under it with more facility, and consequently with less disturbance to the surrounding parts. I have never had reason to believe that a free opening into the fascia of the thigh has done mischief, or even into the sheath, provided the artery has not been unnecessarily disturbed.

The limb after the operation should be enveloped in thick flannel, and the temperature should be carefully measured from time to time. In some instances it is higher than on the sound side, but when it is found on measurement with the thermometer to be less, a bottle of hot water should be applied to the foot, and the warmth of the limb operated upon kept up if possible to the natural standard; but the adventitious heat ought to be but little above it. The wound should not be dressed until the fourth day, the limb being kept quite quiet; the patient should move as little as possible in bed, and the part of the heel on which it rests should be examined from time to time, as it sometimes under pressure becomes gangrenous.

Suppression of the secretion of urine is not uncommon during the first twenty-four hours, and will be gradually removed by the patient's taking mild diluent drinks. The constitutional irritation is frequently great, the pulse rising in forty-eight hours from eighty-five to one hundred and twenty; and if this continues until the third day, when the fear of mortification will have subsided, it should be moderated by the abstraction of a small quantity of blood. In a case on which I operated whilst this sheet was in the press, I have had occasion to bleed twice, and with the happiest effect, the pulse having fallen in consequence to its natural standard. The medicines given at the same time were saline draughts every six hours, with four drops of Batley's solution of opium. The ligatures came away on the fifteenth day.

Operations on the Posterior Tibial and Peroneal Arteries.

The posterior tibial artery may require to be tied between the ankle and the heel. In this situation its pulsation may be felt, and will be the best guide to the artery. It has the tendons of the tibialis anticus, and of the flexor digitorum communis, nearer to the malleolus than itself, and distant about a quarter of an inch; there is a vein on each side of the artery. Posterior to this is the posterior tibial nerve, and nearer the heel the tendon of the flexor longus pollicis; a little below these the artery divides into the external and internal plantar

arteries. To tie the artery at the heel, its pulsation should be felt, and an incision about two inches long made upon it, through the common integuments and superficial fascia; a strong aponeurosis will be found beneath, covering the sheath of the vessels and adhering to the tendons. This aponeurosis must be carefully opened, and then the sheath of the vessels: the artery should be tied with a single ligature. The nerve is nearer the heel.

The posterior tibial artery may be tied a couple of inches higher up in the small part of the leg, by making the incision on the tibial edge of the soleus muscle, under which it lies; but in the middle, or calf of the leg, a different operation should be performed for the purpose of placing a ligature upon it in a case of wound. The old method, and that which I have recommended, have been sufficiently contrasted from p. 257 to 261, to which I now refer. The first incision, six inches long, should be made nearer to the inner edge of the leg than to the centre, and should be carried through the gastrocnemius muscle, plantaris tendon, and soleus muscle, down to the fascia, under which the artery lies with its accompanying veins, having the posterior tibial nerve to the fibular side of it. If the incision has been made in the upper part of the calf of the leg, the peroneal artery will be exposed by it; but if the peroneal artery be the vessel injured, the incision should be made towards the fibular side of the leg; and when the surgeon divides the fascia he will find this artery covered by the fleshy fibres of the flexor longus pollicis muscle, at any distance below three inches and a half from the head of the fibula;

and which fibres must be divided, when the artery will be found close to the inside of the bone. Above that part the artery is under the fascia, and upon the tibialis posticus muscle. It has not an accompanying nerve. Both arteries will be readily found, by either of the incisions described, if the surgeon is acquainted with their situation.

Operations on the Anterior Tibial Artery.

The anterior tibial artery is to be tied in that part of its course in which it may be wounded. When the operation is done for aneurism, it should be performed a short distance above the tumour, and sometimes a second operation below it will become necessary. If the aneurism should be situated so high up, and so close to the origin of the vessel, as not to admit of a ligature being applied anterior to the interosseous ligament, it must be placed on the femoral artery in the thigh, and the result awaited. If it appeared likely to succeed at first, and that the pulsation returned slowly, the artery should be tied below the tumour, because the return of pulsation would probably depend on the blood regurgitating into the vessel; or a ligature may be placed in the first instance upon the trunk of the popliteal artery above where the anterior tibial is given off, by the same operation as is recommended for the ligature of the posterior tibial, the incision being begun a little higher up.

In order to tie the anterior tibial artery near to its passage from the back part to the fore part of the leg,

after it passes into the interosseous space and over the interosseous ligament, and for one-third of its descent towards the instep; draw a line from the head of the fibula to the base of the great toe, which will nearly describe its course. An incision four inches in length is to be made in this line down to the fascia covering the muscles; and if the foot be bent upwards and again extended, the bellies of the tibialis anticus and extensor digitorum communis muscles will be more distinctly seen. The fascia is to be divided for the whole length of the incision between them; and they are then to be separated for the same distance by the scalpel and the finger; the artery will be found close on the interosseous ligament, between its two venæ comites.

In the middle third of the leg, the origin of the extensor proprius pollicis intervenes between the tibialis anticus and extensor communis digitorum muscles. The anterior tibial nerve, a branch of the peroneal, attaches itself to the artery a little above this middle part, and is usually found in front of the artery, although it is not constantly in that situation; care should always be taken to avoid it.

In the inferior part of the leg, the artery lies on the tibia, having the tendons of the extensor digitorum communis on the outside, that of the extensor proprius pollicis on the inside, by which it is overlapped, being also covered by the fascia and the integuments.

On the instep this artery runs over the astragalus, the naviculare, and the os cuneiforme internum, and to the base of the metacarpal bone supporting the great toe. It here divides into two branches, one dips

down between the first and second metatarsal bones, to join the terminating branch of the external plantar artery; the other passes on to the inside of the great, and the opposite sides of the first and second toes. The artery is always to be found on the fibular side of the tendon of the extensor proprius pollicis.

Operations on the Carotid Artery.

The carotid artery may be tied in almost any part of its course, and in the following manner. The patient being seated with the shoulders supported, in such a manner that the light may fall on the neck, the head is to be bent a little forwards, to relax the muscles on the fore part. An incision is now to be made on the line of the inner edge of the sterno-cleido-mastoideus muscle, by which the integuments, the platysma myoides, and superficial cervical fascia are to be divided. The extent of this incision, in persons with long necks, may be from a line parallel with the cricoid cartilage to about half an inch of the sternal end of the clavicle: when the neck is very short, it must be begun as high up as the lower edge of the thyroid cartilage, so as to be as nearly as possible three inches in length. The sterno-cleido-mastoideus muscle is then to be drawn outwards, with any vein which may be seen attached to its under edge. The pulsation of the artery will point out its situation, and the sterno-hyoideus and sterno-thyroideus muscles being drawn and kept inwards, the omo-hyoideus will be seen crossing in the upper part of the hollow thus formed by the se-

paration of these parts. The central tendinous portion of this muscle is attached and fixed by the deep cervical fascia, and lies immediately over the sheath of the vessels, and particularly over the jugular vein. This fascia, which is strong although thin, is to be carefully divided below the muscle, and immediately over the centre of the artery, the position of which is to be accurately ascertained by the finger. At or beneath the same spot, the sheath of the artery is to be opened; and the long thin nerve, the descendens noni, which runs upon the sheath, will at this part be seen inclining to the tracheal side of the artery. It is to be separated and drawn inwards with the muscles. If the sheath of the artery be carefully opened immediately over its centre, the jugular vein will scarcely interfere with it. But as it has been known to enlarge suddenly under the exertions or excitement of the patient, so as to overlap the artery, it has been recommended to make gentle pressure on the vessel at the upper part of the incision, and below if necessary, in order to prevent its occurrence. The aneurismal needle is then to be introduced and passed under the artery from without inwards, by which the jugular vein and the par vagum nerve will be avoided, more particularly if the sheath of the vessels has been undisturbed, save where it has been opened immediately over the artery. The point of the aneurismal needle is to be brought out close to the inside of the artery and within its sheath, by which means all danger will be avoided of injuring either the recurrent or sympathetic nerves which lie behind it. As to the œsophagus, thoracic duct, or thyroid artery,

they are not likely to be injured by any common operator; but he should be aware, that on the left side, if he is obliged to operate low down, he may meet with greater inconvenience from the jugular vein, which is more anterior to the artery, and rather overlaps it, whilst on the right side it inclines outwards from it.

The carotid artery may be tied higher up in the following manner. The incision in this instance should terminate a little below where the former one begins, and must of course proceed upwards for the same length of three inches, in a line extending towards the angle of the jaw. The head should be laid back to enable this to be done, and ought to be kept in that position by an assistant. The artery at this part of the neck is covered by the integuments, the platysma myoides muscle, and the fascia. After the muscle has been divided, the strong fascia must be carefully raised by the forceps and opened, and the operator will do wisely in dividing it upwards and downwards on the director. With the end of the scalpel or a blunt knife he should separate the cellular texture from the veins, which appear in this situation, and are often the source of much embarrassment. The sheath of the artery is to be opened over the centre of the vessel, and the ligature is to be passed around it as before. The descendens noni nerve runs in general on the outside of the artery in this part of the neck, and afterwards crosses over to the tracheal side. The par vagum, which lies in the angle formed posteriorly by the apposition of the carotid artery and jugular vein, and to which latter it is more particularly attached, is to be avoided on introducing the

aneurismal needle; and on bringing it out on the inside the same attention must be paid to prevent injury to the great sympathetic or any of its branches. The surgeon in both these operations should draw the ligature first a little outwards and then inwards, so as to enable him to ascertain that he has included nothing in it but the artery, which is to be tied with two knots; one end may be cut off, or both may be twisted together, and brought out of the wound opposite where the vessel has been tied. The integuments should be accurately closed by adhesive plasters, and the patient put to bed with his head bent forwards, and properly supported. He should eat as little solid food as possible until after the ligature has come away; and observe even greater precautions as to quietude than in other instances.

The external carotid artery may be tied by an operation conducted in a similar manner. After the first incisions have been made, and the strong cervical fascia divided, the operator must feel for the pulsating vessel, which will be found on a line parallel with the cornu of the os hyoides, below which part the common trunk usually divides into the external and internal carotids, the external being the most superficial and internal of the two at their origin. The external carotid turns with its convexity inwards; and nearly opposite but rather above the os hyoides it is crossed by the ninth or lingual nerve, the digastric and stylo-hyoid muscles, and it is below this part it should be tied. Whenever the external carotid is secured by ligature, on account of a wound of a distant part, I am of opinion that the ligature should be applied near to its origin, that is,

immediately below where the superior thyroid artery is given off.

When any of the branches of the external carotid are wounded, they ought to be tied if possible at both ends, and at the part wounded. If this cannot be done, and the hemorrhage demands it, the external carotid is the vessel on which the ligature should be placed; for by cutting off at the same time the anastomosis, a better chance is given for the closing of the injured part of the artery.

Operations on the Arteria Innominata, and on the Subclavian Artery.

The arteria innominata arises from the upper part of the arch of the aorta, on a line nearly parallel with the upper edge of the cartilage of the second rib, ascends obliquely towards the right side, and divides opposite the sterno-clavicular articulation into the right subclavian and the right carotid arteries; the last of which appears to be its continuation, although the smallest in size. The arteria innominata is about two inches in length, rarely exceeding two inches and a half. It is covered by the right vena innominata, which receives the left at a right angle, near the origin of the artery. Exterior to the vena innominata are the sterno-thyroideus and sterno-hyoideus muscles, some strong fascia covering the vein at its upper part, and the first bone of the sternum. The arteria innominata may ascend higher in the neck before it divides, in

which case its pulsation will be perceptible in front of the trachea, and the subclavian artery will cross higher in the neck, which is one reason for not continuing the external incision down to the sterno-clavicular articulation in the operation on the right carotid. The subclavian artery, given off behind or a little above the articulation, proceeds outwardly for the space of one inch before it reaches the inner edge of the scalenus anticus muscle, which is about half an inch in width; so that the subclavian artery, when it clears the outer edge of the scalenus anticus muscle in a tall man, is not more than one inch and a half or three quarters from its origin, even to the spot at which a ligature is usually placed upon it. The first branch given off is the vertebral on the upper and back part of the artery, and distant from the carotid at the bifurcation half an inch. The thyroid axis is given off at the anterior and upper part of the artery, a quarter of an inch more outwardly, and the internal mammary often arises directly opposite from the anterior and inferior part of the artery, descending into the chest behind the junction of the first and second ribs with their cartilages. The inner edge of the scalenus anticus muscle is close to these two last vessels. The phrenic nerve crossing this muscle obliquely lies on the outside of the thyroid axis, and on the inside of the internal mammary artery, having crossed the subclavian artery at this part; and descends between it and the junction of the internal jugular and subclavian veins to the chest. Internal to this, some small branches of the great sympathetic nerve, which lies itself behind, pass over the artery; and still

more internal, but distant about a quarter of an inch from the carotid artery, the par vagum crosses likewise. The only point at which the subclavian artery can be tied internal to the edge of the scalenus anticus muscle is at this point, on the inside of the par vagum, and in a space scarcely more than one quarter of an inch in width, and to which the carotid will be the best guide. It appears to me, that a ligature may be as readily and as safely applied around the innominata immediately below its bifurcation, as around the subclavian close to the same spot.

From this view of the parts it will be evident, that the operation may be advantageously done in the following manner. Raise the shoulders of the patient, and allow the head to fall backwards, by which the artery will be drawn a little from within the chest. Let an incision be made over and down to the sterno-cleido-mastoideus, the sternal origin of which, and nearly the whole of the clavicular origin, should be divided on a director, carefully introduced below it, avoiding some small veins which run below and parallel with its origin. An incision is now or previously to be made two inches in length along the inner edge of the muscle, which will admit of its being raised and turned upwards and outwards. Some cellular texture being torn through, the sterno-hyoideus muscle is brought into view, and must be divided on a director. The sterno-thyroideus is then to be cut through in a similar manner. A strong fascia and some cellular texture here cover the artery, having the nerves above mentioned running beneath it, the carotid being to the inside, the internal jugular vein to

the outside. By following the carotid downwards, the finger will rest on the innominata and on the origin of the subclavian, and a ligature may be placed on either. If on the innominata, the aneurismal needle, and Mr. Weiss's will perhaps be the best, must be passed from without inwards, immediately below the bifurcation, and close to the vessel. If on the subclavian, the surgeon must recollect, that there is only about a quarter of an inch of this artery on which the ligature can be applied; this small space being bounded internally by the carotid artery, and externally by the par vagum above, and the vertebral artery below. The ligature should be applied close to the vertebral artery, the needle being passed from below upwards; the greatest care being taken to avoid the recurrent nerve, which separates from the par vagum at this part, and winds under the subclavian and carotid arteries, to be continued upwards to the larynx. If the ligature be placed on the arteria innominata, the same care must be taken to draw the par vagum outwards, and to avoid the recurrent nerve. The edges of the wound should be brought together and dressed in the usual manner; the head being bent forwards on the trunk, and maintained in that position in order to relax the parts, and admit of their being kept in apposition.

This operation ought only to be performed in cases of aneurism of the subclavian artery, in which it is presumed that the disease extends as far as the external edge of the scalenus anticus muscle, but not more inwardly. The case of J. P., related page 17,

may have been a proper one for this operation at an early period of the disease. The arteria innominata has been tied by Dr. Mott of New York; the ligature came away on the fourteenth day, but the patient died from hemorrhage, the consequence of ulceration of the artery, on the twenty-sixth day after the operation. It has also been performed by Dr. Graefe of Berlin, but the patient also died from hemorrhage on the sixty-seventh day. It is evident from these last cases, that a man may live so long after the operation as to show that he does not die from the immediate effects of it, or from any that must necessarily take place; and it is therefore probable, that if the operation be repeated it will ultimately be successful, although it must always be exceedingly hazardous.

The left subclavian artery rises perpendicularly out of the chest like the innominata, but on a plane much posterior to it, so that at the part where the vertebral artery is given off, and which is about an inch and a half from the origin of the artery, it lies nearly an inch deeper from the surface than the vessel on the opposite side. It is covered by, or is more directly connected with, the important parts which are only in the vicinity of the right subclavian. The pleura adheres to it, and must be torn in putting a ligature around it. The par vagum is parallel and anterior to it. The internal jugular vein and the left vena innominata lie over it. The thoracic duct and œsophagus are connected with it; and the carotid artery is in front. So that with the most careful dissection it appears impossible to place a ligature upon the as-

cending portion of the left subclavian artery, without doing more mischief than is compatible with the life of the patient.

Aneurisms of the arch of the aorta have been sometimes known to appear so far beyond the outer edge of the scalenus anticus muscle, as to impress the surgeon with the idea, that they arose from the subclavian artery, and that an operation on that vessel might be attended with success. This error is not likely however to occur in the present day; the stethoscope will always point out the existence of such an aneurism within the chest, and will therefore demonstrate the impropriety of the operation. I may be permitted however to remark, that I have never seen an aneurism of this nature that was not attended by some circumstances indicating its more internal origin, independently of the information derived from the stethoscope; but an operation should only be attempted when the case is free from doubt.

Whenever an aneurismal tumour in the neck is accompanied by any alteration of the sterno-clavicular articulation, the case is clearly one totally unfitted for any operation save that suggested by Desault and Brasdor, and revived by Mr. Wardrop, even if an operation be at all admissible. The same may be said of any case of aneurismal swelling, either internal or external to it, in which the stethoscope applied on the sternum in the course of the arteria innominata, or of the arch of the aorta, indicates disease. A swelling at the root of the carotid is more likely to be an aneurism of the arch of the aorta, or of the ar-

eria innominata, than of the carotid itself, and the stethoscope will remove all doubt.

The subclavian artery has been frequently tied above the clavicle, and *external* to the scalenus anticus muscle. It should be done in the following manner. The patient being placed horizontally on the table, in such a situation that the light may be directed into the hollow in the bottom of which the artery is to be tied, the shoulder is to be depressed, and an incision made along the edge of the clavicle, commencing one inch nearer the sternum than the clavicular edge of the sterno-cleido-mastoideus muscle, and carried outwards to the extent of three inches and a half or four inches. The platysma myoides and superficial fascia are to be divided, taking care not to injure the external jugular vein, which should be drawn to the outer side of the wound. By this incision the edges of the trapezius and sterno-cleido-mastoideus muscles will be exposed.

The object of the operation is in the first instance to reach the outer edge of the anterior scalenus muscle: this lies immediately below the outer edge of the clavicular portion of the sterno-cleido-mastoideus, and the division of a portion of this part of the muscle will greatly facilitate the subsequent steps of the operation, although it may be done without it. The artery will be found crossing over the first rib at the very edge of the attachment of the scalenus anticus to it; but a quantity of cellular substance and fascia intervene, which must be torn through before it can be exposed. This should be done with a blunt round-pointed knife,

in a line parallel with the first incision, but more immediately over the outer edge of the scalenus muscle. The omo-hyoideus muscle passing obliquely across the root of the neck will be in this manner exposed, which should be clearly done, because it narrows the space in which the operation is to be performed to a small triangle, the outside and apex of which is formed by this muscle, the inside by the scalenus anticus, the base by the rib, above it the subclavian vein, and above it again, but under the clavicle, the supra-scapular artery and vein. The blunt knife working in the triangular space, will first expose one or more of the nerves of the axillary plexus, which again diminishes the space; more inwardly the scalenus anticus will be felt, and should be seen by tearing through the thin fascia which lies behind the omo-hyoideus and is connected with it. The point of the finger, assisted if necessary by the blunt knife, should be passed along the edge of the muscle until it rests on the first rib, and at the angle formed between the muscle and the rib, the artery will be found and known by its pulsation. The operator should detach the artery in a slight degree from its connections with the point of the nail, and the aneurismal needle should be passed in preference from below upwards, by which the pleura will be avoided. After the ligature has been passed under the artery, the vessel should be pressed upon with the point of the finger, whilst the ligature is firmly held in the other hand, by which the circulation through the artery will be stopped, and the pulsation in the tumour and at the wrist will cease, when the ligature may be tied with a double knot; and for doing this

one or two steel probes, having a ring at the end of each, placed at a right angle with the shaft, will afford great assistance.

In some instances, and particularly in short-necked persons, the omo-hyoideus lies close to the clavicle, and requires to be drawn upwards and outwards from it. In others, the lowest nerve of the axillary plexus lies over the artery, and may be mistaken for it. When the veins coming from the neck are large and numerous, more care must be taken to avoid injuring them, as they frequently cause, not only much hemorrhage but great delay.

Operations on the Axillary Artery.

The patient being firmly supported or placed in the horizontal position, the arm is to be slightly separated from the body, and an incision is to be made in the course of the axillary artery, through the integuments, superficial fascia, and great pectoral muscle, in fact through the anterior fold of the armpit. The length of the incision will depend on the part at which the artery is to be secured. It may begin however, as a general rule, over that part where the pectoral muscle first touches the deltoid. The parts divided being separated, the pectoralis minor will be seen crossing at the upper part of the wound to the coracoid process, and the artery may be felt below it, enclosed in its cellular sheath, with the nerves of the arm and its venæ comites.

At the lower edge of the pectoralis minor, the artery

is crossed by the outer of the venæ comites, which passes between the external cutaneous and the external origin of the median nerve, at the spot where they separate from the plexus. The artery may be tied below this separation, or the nerves and vein may be drawn to the outside, and the artery tied above the union of the external with the internal root of the median nerve and as high as the origin of the arteria thoracica acromialis, the pectoralis minor being either raised and pushed upwards, or divided. The internal root of the median nerve is in connection with the internal cutaneous and ulnar nerves; the larger of the venæ comites is to the inside and behind, but as it ascends it receives its fellow, and with the cephalic vein forms in front of the artery the subclavian vein.

Operations on the Brachial Artery.

The brachial artery can be traced by its pulsation from the lower edge of the teres major muscle to below the bend of the arm, where it is covered by the pronator teres muscle. At first it is to the ulnar side of the humerus, resting on the triceps, and slightly overlapped by the coraco-brachialis and biceps muscles. In the middle of the arm it rests on the tendon of the coraco-brachialis, is close to the bone, and lies under the lower edge of the biceps; in which situation it may always be compressed by bend-

ing the fore arm, so as to cause the belly of the biceps to enlarge, when pressure made immediately below it will arrest the circulation in the brachial artery. It then crosses towards the anterior part of the arm and rests on the brachialis anticus muscle until it passes the bend of the elbow. It is accompanied by two veins, which are connected to it by a loose cellular membrane forming a sheath. The external cutaneous and median nerves lie a little to the outside of the artery at the upper third of the arm. In the middle third the median nerve lies generally in front of, but sometimes between the artery and the bone, and is on the inside at the inferior part. The internal cutaneous nerve runs parallel but superficial to the artery, the ulnar nerve nearer but posterior to it. When a ligature is to be placed on the brachial artery in the upper part of its course, the incision should be made about three inches in length, and directly on the line of the pulsating vessel, by which all mistakes will be avoided. The integuments should be divided carefully, that the internal cutaneous nerve may not be injured; the fascia is then to be cut through and the fore arm bent, when the vessels and nerves will be relaxed. The artery is to be separated from its veins, one on each side; and it must be recollected that the external cutaneous and median nerves are to the radial side of the artery, the internal cutaneous and the ulnar nerves to the ulnar side of it. In the middle of the arm the median nerve lies immediately over the artery, except in cases where it passes behind it; and when it lies in front it may be mistaken for the artery, from the

pulsation being communicated to it. The incision should be to the same extent of three inches, directly in the course of the artery, and the ligature should be passed from the ulnar to the radial side of the vessel, in order to avoid the possibility of including the internal cutaneous or the ulnar nerves, and carefully excluding both the veins.

Operations on the Ulnar Artery.

The ulnar artery may be tied near the wrist, where it is most superficial. Bend the wrist, so as to make the flexor carpi ulnaris act, when the tendon will be felt internal to the styloid process of the ulnar; make an incision two inches and a half in extent along the radial edge of this tendon, dividing the fascia of the arm which covers it. The artery will be felt below the deep-seated fascia, and on dividing it will be seen with its venæ comites, the ulnar nerve being behind it, and which must be avoided in the application of a ligature. In the palm of the hand, the ulnar artery having passed over the annular ligament of the wrist, is covered by the integuments and the palmar aponeurosis. To tie the ulnar artery in the *middle third* of the arm, the surgeon should bend the wrist, and trace upwards the tendon of the flexor carpi ulnaris as far as it can be felt. At the point where it becomes indistinct an incision should be com-

menced and carried upwards for the space of four inches; the fascia is then to be divided for the same extent, when the flexor carpi ulnaris may readily be traced upwards by its tendon, which is on the radial side of it; this muscle may then be easily separated from the flexor sublimis, beneath the edge of which the artery will be found covered by the deep-seated fascia, having a vein on each side, and the ulnar nerve to the ulnar side of it. By this method of proceeding the artery will be readily exposed, which is not always the case by any other manner of operating, and may be tied as high up as where it passes from under the flexors of the arm. It can only be necessary to tie the ulnar artery in the upper third of the arm in consequence of a wound; and in this situation it has been considered impracticable to do it. It may however always be done, and without much difficulty.

The brachial artery, a little below the bend of the arm, divides into the radial and ulnar arteries. The radial being the continuation of the brachial in direction, the ulnar in size. The brachial artery, at the bend of the arm, is cushioned on the brachialis internus muscle, having the tendon of the biceps on the outside, the median nerve on its inside, which is at first continued on the same side of the ulnar artery; but as that vessel inclines towards the ulna for about an inch, and then passes between the two origins of the pronator radii teres muscle, the median nerve crosses it at this part to get into the middle of the arm, and is then separated from it by the ulnar origin of the muscle. The artery continues its course, inclining outwardly,

under the pronator radii teres, the flexor carpi radialis, the palmaris longus, and the flexor sublimis muscles, lying on the flexor profundus. On clearing the ulnar edge of the flexor sublimis, it is covered by the flexor carpi ulnaris; and at this part it may be tied by the preceding operation, the course of the artery having been obliquely under these muscles for the extent of two inches. To tie it in any part of this course, they must be more or less divided, and the only difficulty or danger arises from the median nerve, which lies deep under the radial origin of the pronator teres. But the whole of the muscular fibres may be divided without injuring the nerve, by successive and careful incisions through them until the artery and nerve are exposed, and a ligature may then be applied above, and below the wound in the vessel. It may be supposed by way of elucidation, that a man receives a wound from a sword through the flexor muscles, which injures also the ulnar artery, as may be presumed from its situation, and the continued and impetuous flow of blood. It shall be further supposed, that this wound is in a slanting direction from the ulna towards the radius. The surgeon may, if he thinks he can calculate the point at which the artery is injured, cut down upon it in the direction of the fibres of the intervening muscles, and even through them until he reaches the artery; but if he has erred in his calculation he must introduce a probe, and after having ascertained the line the wound has taken, he should cut across the muscular fibres in that direction until he exposes the bleeding artery, and if he is

careful not to divide the median nerve, no inconvenience will arise from the operation.

If the ulnar artery is wounded near its origin, and through the radial side of the pronator teres muscle, an incision should be made through the integuments and the aponeurosis of the biceps muscle; the pronator muscle being then laid bare, it is to be drawn inwards or towards the ulna, and the dissection continued until the median nerve is exposed. The probe introduced through the original wound will lead to the artery, the pulsation of which will be felt and the bleeding seen. As the nerve crosses the artery, the vessel will be found above to the radial side of it, and to the ulnar side below. It may be tied above without dividing a muscular fibre; but at the part where the nerve crosses and below it, some fibres of the pronator teres must be divided, and in some cases the whole of them, before the artery can be properly secured by two ligatures.

Operations on the Radial Artery.

The radial artery may be secured by ligature with great ease in any part of its course to the wrist. At the upper third of the arm, the radial artery is covered by the junction of the supinator radii longus and pronator teres muscles. To expose it at this part, a line may be drawn from the middle of the bend of the arm to the thumb, which will indicate its course; or

the supinator radii longus being put into action, an incision is to be made from the bend of the arm obliquely outwards along its ulnar edge, to the extent of three inches, avoiding the median vein, but dividing the integuments and the fascia. The supinator muscle is then to be gently separated from the pronator teres by the point of the knife or by its handle, and the artery will be felt covered by the deep-seated fascia; on the division of which, it will be seen with its venæ comites lying on some adipose membrane, and on some branches of the spiral nerve, which separate it from the tendon of the biceps, and which are to be carefully avoided. The musculo-spiral nerve itself lies nearer the radius, which renders it advisable to pass the aneurismal needle from that side.

In the middle third of the fore arm, the inner edge of the supinator radii longus marks the line of the incision, which should be to the extent of three inches. The fascia being divided, the supinator longus is to be separated from the flexor carpi radialis, and on the division of the deep fascia, the artery will be found passing with its venæ comites over the insertion of the pronator radii teres, and the radial origin of the flexor digitorum sublimis. The musculo-spiral nerve lies close to the radial side of the artery.

Near the wrist, the radial artery may be tied with great facility. Make an incision two inches and a half long on the radial side of the tendon of the flexor carpi radialis, which becomes prominent on bending the wrist; the superficial and deep fascia are to be divided, when the artery and its veins will be exposed; the nerve has

not accompanied the artery to this part, where it lies, first on the flexor pollicis longus, then on the pronator quadratus, and lastly, in crossing round to the back of the hand, on the radius alone.

The radial artery, on reaching the base of the first bone of the thumb on the back of the hand, lies close to it and under the three extensor tendons of the thumb. It then dips down between the first bone of it and the metacarpal bone of the fore finger, and enters into the palm of the hand, to form the deep-seated palmar arch; sometimes passing behind the abductor indicis and adductor pollicis muscles, sometimes perforating them.

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THE END.

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