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ANATOMY, PHYSIOLOGY, [illegible]

SURGICAL PATHOLOGY

OF THE

VASCULAR SYSTEM

[illegible]

THE HUMAN BODY,

[illegible]

[illegible] OF SURGEONS [illegible] LONDON

[illegible] THE YEAR [illegible]

BY JAMES WILSON, [illegible]

PROFESSOR OF ANATOMY [illegible]

AND LECTURER ON ANATOMY AND SURGERY

IN THE [illegible] SCHOOL IN GREAT WINDMILL [illegible]

LONDON:

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LECTURES ON THE BLOOD,

AND ON THE

ANATOMY, PHYSIOLOGY,

AND

SURGICAL PATHOLOGY,

OF THE

VASCULAR SYSTEM

OF

THE HUMAN BODY,

DELIVERED BEFORE THE

ROYAL COLLEGE OF SURGEONS OF LONDON,

IN

THE SUMMER OF THE YEAR 1819.

BY JAMES WILSON, F.R.S.
PROFESSOR OF ANATOMY AND SURGERY TO THE COLLEGE,
AND LECTURER ON ANATOMY AND SURGERY
IN THE HUNTERIAN SCHOOL IN GREAT WINDMILL STREET.

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1819.

TO

MATTHEW BAILLIE, M. D.

F.R.S. L. & E.

PHYSICIAN TO THE KING.

To whose early good opinion and encouragement I am indebted for whatever share of reputation I possess, as his Successor in the Anatomical School of his illustrious Uncle, and to their continuance during a period of Thirty-six years for constant and unremitted acts of kindness and friendship; to whose exertions, in conjunction with those of Sir Everard Home, our College is indebted for the invaluable national gift of the Museum of his other equally distinguished Relative; and our

Profession for the most liberal encouragement of whatever relates to the improvement of Surgical Science, I respectfully beg to dedicate these Lectures, and to subscribe myself with such grateful feelings as one so long honoured by his friendship cannot but possess,

His most obliged

and sincere Friend,

JAMES WILSON.

George Street, Hanover Square.
September 1st, 1819.

TO THE READER.

As novelty forms but a small part of the contents of this volume, some reason should be given for its publication. I was called upon rather suddenly, and certainly unexpectedly, to deliver the Anatomical and Surgical Lectures at the College; my respect for the opinion of the Members of the Court of Assistants who did me the honour of naming me to that office, rendered it impossible for me to refuse attempting the duties of it; but at the same time, I felt that the avocations connected with my professional business, would not allow me to devote so much time as I could have wished to search for matter which might render the Physiological Discourses I had to deliver, acceptable from their novelty, and in Anatomy and Surgery, I could have no matter but that which I had long taught and continue to teach in the Windmill Street School. I have never considered that the exertions of the Lecturer should be confined to attempts at displaying new facts and new reasonings; he would thus be continually obtruding on his hearers an ill-arranged assortment of crude materials, and would be exposing himself and them to the specious imposture of old matter, wearing the disguise of novelty, or would neglect the instructive observations by which such facts as were really new and intrinsically valuable had been established. The previous range of the intellect should surely be defined before attempts are made to extend its limits, and the memory should be refreshed before the imagination is exercised.

Thus I have endeavoured to bring forward to observation such materials only as appeared to be useful, rather than new matter, and have attempted nothing beyond plain facts, and I hope intelligible reasoning on them. Had I not thought that such Lectures as I conceived worthy to be listened to by the College of Surgeons in London, might prove useful elsewhere, I never should have published them. The Lectures appear before the public as nearly as possible in the form in which they were delivered, the observations connected with the demonstration of some of the preparations being necessarily omitted.

The Reader will perceive that the language, in many places, is much more colloquial than it would have been, had it been intended for publication and not for oral delivery, and that much matter which in a publication might have been conveyed in the form of notes, was from the nature of a public Lecture introduced, of necessity, in the body of the discourse.

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LECTURE I.

INTRODUCTORY OBSERVATIONS.
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GENTLEMEN,

IN obedience to the orders of the Master, Governors, and Court of Assistants, I now appear before you, as one of the Professors of Anatomy and Surgery to our Royal College. However gratified and honoured I may feel, in having been the object of their choice, I cannot but also strongly feel the responsibility I have incurred in accepting this important office, and the difficulties which must attend the proper execution of the duties connected with and attached to it.

I have for many years delivered lectures on Anatomy and Surgery; but to hearers of a different description from those whom I have now the honour to address. In those lectures my duty was properly defined; the arrangement of them was obvious, and attention to them was secured by the novelty and variety of the subject, and the conviction of the pupil, that each succeeding lecture would advance him nearer to the object of his ultimate research.

I have now before me, those who from talent and experience, have long been thoroughly acquainted with all that relates to their profession, and have most deservedly acquired all those gratifying distinctions, which a zealous and honourable practice of it can alone procure; those who are actively and sedulously employed in the daily exercise of it; and those who, though still students, have made considerable advances in anatomical and surgical knowledge, by having attended the lectures delivered in the various schools, and witnessed the practice used in the different hospitals of this great metropolis.

To such an audience, the lecturer cannot offer that minute detail of particular circumstances in Anatomy, which must *once* be known by those beginning to study that science; nor *should* he, in his attempts to avoid this, pass over too slightly those first principles, which lead to the better understanding of the natural structure and functions of the human body; or the treatment of the accidents, and cure of the diseases, incident to its complicated machinery. But thus situated, if the lecturer uses his abilities to the best of his power and judgment, in fulfilling the intention for which the lectures were established, he is sure that his attempt will be received with liberality and candour. For we do not meet here merely to be instructed in new matter by the lecturer, but rather to use him as the means of enabling us to review, compare, and arrange the materials of knowledge, already deposited in the storehouse of the mind, so to know their exact place and connection, that they may be produced immediately, untarnished by neglect, when our patients' necessities and our own character call for their employment. The lecturer on anatomy and surgery is useful here, only as the dial is to the sun, which, without adding any thing to its heat or brightness, points out the course of its advancement, arrests our attention to its present height, and shews how far it has still to proceed. So considered, he may occasion our retrospect of time passed in the pursuit of science to produce useful reflexion; our present view of it honourable emulation, and perhaps, suggest in perspective the means of future improvement.

The lectures which I am called upon to deliver in this Theatre, consist of six, formerly founded by Aris and Gale, on *Human* Anatomy and Physiology; and nine which are called Museum Lectures on Surgery. I have received instructions from the Board of Curators, that the lectures should be illustrated as much as possible, by preparations from the Museum of the College.

The important advantages to be derived from a successful cultivation of Anatomy are so obvious, that this science is now with general assent admitted to be the only solid foundation of medicine and surgery. It is not, however, solely a *general* knowledge of Anatomy that is necessary to the surgeon; but the most particular and accurate that can be acquired. This is to be obtained, not merely by attending a few courses of anatomical lectures; but by an attentive and persevering study, an intimate acquaintance with the practical part of dissection, and by a continued or frequent exercise of the art, so long as we continue in the practice of our profession. This was the opinion invariably delivered to, and zealously impressed on his pupils, by my first instructor in anatomy, Doctor William Hunter.

By the united efforts of men of genius, talents, and industry, through a number of centuries, much has been done, in increasing the knowledge of anatomy and physiology; but much still remains to be done. The progress of the sciences is necessarily slow; their advancement is usually the work of a series of ages, and even in those which have been the longest and most successfully cultivated, we meet with many voids most difficult, (from our want of proper materials,) to close up; and indeed the perfection of some of them seems to recede in proportion, as efforts have been made to approach it.

The chain of connection which pervades the whole of the works of nature, prevents our being thoroughly acquainted with any one part, unless we possess some knowledge of the neighbouring links. All arts and sciences consisting of an accumulation of facts depending on certain principles, are derived from observation, and perfected by experience and reflection; but some require less degrees of these qualities than others: thus Sculpture and Painting, requiring little more than imitating nature, as she is represented to our senses, are within the reach of an individual, and have been frequently brought near to a state of perfection, by the exercise of his single unassisted abilities. A peculiarity of genius has enabled some men, in very early ages, to excel in Poetry, Eloquence, and the knowledge of the Mathamatics, in an equal degree, at least, to any of their successors, (witness the names of Homer, Demosthenes and Euclid.) But those arts and sciences which are more complicated, and which do not depend solely on the effort of the mind, must be slow in their progress; they will remain long in their infancy, and will advance more or less rapidly in proportion to their dependance on those connected with them, being more or less known. To understand the action of our bodies, we require some aid from almost every other art and science; many of these are still far from perfection: it therefore affords no matter for surprise, that our progress in Physiology has been so slow—as other sciences improve, our physiological knowledge will be proportionably increased.

As Anatomy is the knowledge of the materials of the body, so is Physiology the knowledge of the use of these materials. When well instructed in these sciences, the Surgeon will find innumerable occasions of deriving advantage from them; when ignorant of them, he must be continually exposed to mistakes, and frequently to those of the most fatal nature. For proof of this, I refer you to the sensible and convincing arguments, used by one who has done so much honour for several years to our professional chair, in that excellent oration which he lately delivered. An oration, which taken in all its parts, in regard to arrangement of matter, and eloquence of delivery, has seldom been equalled, and perhaps never excelled. I should offer a bad compliment to your memories, did I attempt to repeat any of these arguments; for no part of the substance of that discourse is likely to be forgotten by those who were so fortunate as to hear it. In saying this, there is no flattery; I appeal for its truth to the judgment of all those who heard Mr. Abernethy's Oration. In common with every other hearer, I must have admired the accuracy and discrimination with which the industry, the talents, the comprehensive and ultimate views of John Hunter were placed before us; and as one educated in the school of that great man, and his illustrious brother, I could not but gratefully feel, that such a man, and such doctrines, had met with an Orator equal to the important task.

The best tribute to the memory of John Hunter which I can offer you, will be to produce to you some of his preparations, and confessing my inability to do justice to the subject, to endeavour to explain them, and his views in making them, as illustrative of doctrines which have so much improved our art, and consequently been so beneficial to the cause of humanity.

To the blindness, ignorance, or caprice of Lord Bute's administration, this City owes the loss of that collection of preparations, which one of the illustrious Brothers so generously offered to the public.

To the liberality of a more enlightened government, under the administration of William Pitt, at the suggestion of Sir Everard Home, whose zeal for the advancement of surgery is well known to all present; and Doctor Baillie, the mention of whose name excites sentiments of esteem, respect and honour, we are indebted for the attaching of John Hunter's splendid collection to the Museum of our College, and for the information we have received from those eminent Professors who have hitherto delivered the conditional lectures, required by government for such a gift.

The protection and encouragement which our College has received from government, has been repaid by the rapid advancement and diffusion of the knowledge of the principles of Surgery, and established the important fact, that the improvement of the arts and sciences will ever afford the most durable monument of the good sense and real grandeur of the governments which have encouraged them.

The preparations of John Hunter, and uses hitherto made of them, will afford some refutation of an observation made by the most scientific man of his age, Francis Bacon Lord Verulam—when speaking of medicine and medical practitioners, he says, " In the inquiry which is made by Anatomy, " I find much deficience ; for they inquire of the " parts, and their substances, figures and colloca- " tions ; but they inquire not of the diversity of " the parts ; the secrecies of the passages, and the " seats or nestlings of the humours, nor much of " the footsteps and impressions of diseases ; the " reason of which omission I suppose to be ; be- " cause the first inquiry may be satisfied in the " view of one, or a few Anatomies, and the latter " being comparative and casual, must arise from " the view of many."—(*Vide Tom* 1. *Anatomia Comparata)*

I know not whether John Hunter ever read this passage ; but it is most certain, that his pursuits were devoted to render the assertion, however true it might have been, no longer to remain, a just, but severe reflection on our art.

In the year 1653, Edward Arris left to the then Corporation of Barber Surgeons, a sum of money for establishing an Anatomy Lecture. About 1698, John Gale left a sum of money for the same purpose. For many years lectures were given on these foundations by the former professors of Anatomy to the Corporation.

These lectures, founded by sensible and respectable men, at a period when the want of anatomical knowledge must have been severely felt, and when the difficulties in acquiring it in this country were almost unsurmountable, will now allow of the recommendation so urgently impressed by Doctor William Hunter being partially acted on.

In delivering them, the Lecturer will endeavour to remind some of the older and more experienced members, of circumstances with which they must formerly have been well acquainted; but the complete remembrance of which, from many causes, might now be somewhat obscured; he will endeavour to make them an useful exercise to the minds of those now actively engaged in anatomical pursuits, and he trusts they will, at least, have the effect of rendering the explanation of diseased structure more intelligible, from having brought the natural structure and actions of parts recently to our recollection.

On considering what Anatomical and Physiological subjects should be first selected for these lectures, it appeared, that the vascular system had the greatest claim to our attention; as the qualities of the blood, and the structure and action of its containing vessels, must frequently and necessarily be alluded to in investigating the nature and treatment of those diseases or accidents, which might require our professional aid. Few of these diseases or accidents, would be unaccompanied by inflammation, and the existence of inflammation is judged of by the alteration the blood undergoes, and the increased action of some of the vessels containing it.

This system comprehending the blood, the muscular fibres, as entering into the composition of the heart and blood vessels, the heart, the arteries, the veins, and the absorbents, will call for some observations on each of these subjects; and in adopting this arrangement, the plan laid down and acted on by the founder of the Museum, which is now attached to this College, is nearly followed. In these lectures, more attention will be paid to the arrangement of known facts, than to the novelty of dubious ones. Although the lecturer cannot be reasonably called upon to make discoveries, or to teach new doctrines; his audience have certainly a right to expect, that some useful arrangement should be made, or justifiable inference drawn from those already before the public.

BLOOD being the fluid contained in the heart, the arteries, the veins and their appendages; and being constantly during life propelled from the heart to every part of the body, and from every part back to the heart; it has been selected for the first subject of observation.

The blood being fluid while circulating in the body, is more uniform in its appearance, than any of the solid parts; these admitting of much variety both in appearance and in structure. Blood can be examined with less reference to the other parts, although it enters into the composition of every other part; all the secretions of the body are from it; and all the substances appropriated to produce or augment the solids, or to repair the injuries done to the body are immediately furnished by it. It is thus essentially necessary to the life of every other part of the body. It is altered in many of the diseases affecting the body, and sometimes in a greater degree than the solids; its changes, therefore, have been attended to in disease, and from them, information has been obtained of the nature of the disease.

While circulating in the body, we do not discover from its appearance, that the blood is composed of dissimilar parts; its properties, therefore, as a general circulating mass, shall first come under consideration, and then those properties which we can only become acquainted with by examining it when out of the body.

Widely different opinions have been entertained as to the quantity of blood in a living human body of a given weight, and the ascertaining of it has been attempted by various experiments. It is, however, absolutely impossible to ascertain the exact quantity with any great precision; and even if it could be done, the knowledge of it would not prove materially useful. From the variety of experiments, however, which have been made, most Physiologists seem to agree, that the quantity of blood in the body of a man who weighs 160 lb. may be on an average about 28 lb.; but will be subject to occasional variation from many causes, without the general health being affected. Haller supposed that at least 50 lb. of fluids circulated, of which about 28 lb. he considered to be true blood.

The quantity of blood in an animal body, will vary from many other circumstances than the size of the animal: *e. g.* Young animals possess more blood than adult animals, as more is to be expended in forming or increasing the size of their bodies. Adult animals possess more blood than aged, as in their period of life the body is to be supported in a perfect state, and secretions supplied to form others; whereas in the aged, from an established law of nature, the vascularity of the body progressively diminishes, and the whole frame gradually decays. Fat animals are found to possess less blood than leaner animals; and tame animals, which are confined, less blood than wild ones.

In different parts of the same animal, the quantity of blood will also be found to vary; and the quantity sent to each will be found proportioned to its particular use; thus glands, viscera, muscles, bones, tendons, ligaments, &c. will have different quantities; their use for it, not their bulk, regulating this.

The motion of the blood being produced by its containing vessels; the rate of its motion must be different in different vessels of the same body. It will move quicker in the large arteries nearest the heart, and slower in the smaller and anastomosing branches; when blood is received into a larger from a smaller cavity, its impetus and velocity will be proportionably lessened to the size of the new vessel; the blood thus moves slower in the veins than in the arteries; on account of their greater distance from the heart, their greater number, and their increased size.

Its fluidity allows of its being propelled through flexible tubes, and of the proper quantities being separated from it which are destined for the growth, support, and occasional repair of the body, and for the various secretions.

The colour of the blood is well known to be red, in the human bodies, and in animals of warm blood. It varies, however, in its degrees of redness in different classes of these animals. In certain insects the blood is colourless; so that redness of colour is not be regarded as an essential characteristic of blood. In Amphibia and Fish, the vital parts only, such as the heart, liver, and gills, are supplied with red blood, while the bulk of the animal, consisting of muscle, bone, &c. is supplied with colourless blood; even in our own bodies, we have parts whose vessels are too small to admit the circulation of red blood, and which therefore being supplied with colourless blood, appear of a white colour; we have an example of this in the tunica conjunctiva of the eye.

Although red is the general colour of the blood, it has many shades of difference in different vessels of the body: we know that in the pulmonary veins, in the left side of the heart, and in the aorta and its branches, the blood is of a beautiful florid scarlet colour. In the veins returning it from every other part of the body, in the right side of the heart, and in the pulmonary artery, the blood is of that dark red colour, usually known by the name of modena red; indeed in the veins nearest to the heart, its colour is purple, and very nearly approaches to black.

It is changed from the florid scarlet to the dark colour, in passing from the ramifications of the aorta into the veins. Microscopical observations have shewn it becoming darker in the smaller arteries, and where the circulation has been rendered slower by any extensive anastomosis of vessels. It has been found to become darker in the living body, when kept at rest in arteries, and not exposed to air; and extravasations of arterial blood into cavities, if not exposed to air, assume in time the dark colour.

Although the blood is generally dark in the veins of the body, it is not always so: for when in bleeding, a large orifice has been made in a cutaneous vein, the blood which immediately follows the withdrawing of the lancet, is dark; but it is sometimes succeeded by blood of a florid scarlet colour. The blood is also found to be of a florid scarlet colour, in the veins of a part affected by phlegmonous inflammation.

The blood changes from the dark to the scarlet colour, in passing from the pulmonary artery, to the pulmonary veins.

It has been supposed by many, that the scarlet blood exclusively possesses the property of supporting the life of those parts to which it is sent; this however, is not borne out by facts. It also appears, that the blood must undergo a more essential change in the lungs, than merely that of colour; for in the fœtus, while in utero, a mixture of florid and dark blood, constantly circulates in the arteries, which are employed in forming the child, and in increasing its bulk. In cases of Aneurisms, which have been of long continuance, and in those where the operation of tying the artery has been performed, dark coloured blood is employed in supporting the life of that part of the limb, which is situated below the tumour or ligature.

The heat of the blood while circulating in the living human body, in vessels near the heart, is about 99° of Fahrenheit's thermometer. The temperature of the surrounding atmosphere does not affect it, it continues the same in summer and in winter, in Lapland and the East Indies. The heat in different parts of the body has been found to vary a little; John Hunter found that when a thermometer, constructed for the purpose, was introduced into the rectum, the mercury rose to $98\frac{1}{2}$°, when introduced into the penis, at the end of the urethra, it rose only to 92°; but in all parts where much blood is sent, and whose surfaces are not exposed to an extensive application of cold, the heat of blood will not be under 98° or 99°. The heat has been found to have diminished a very few degrees in the cold fit of an ague; but rarely, if ever, has it been found under 94°.

It has been found to have increased a few degrees in inflammatory fever; but very rarely indeed has it been known to rise to 110° and never I believe to 112°. These observations on the heat of the blood, apply only to the blood of the human body and that of the more perfect classes of quadrupeds; for some fish, and most of the more imperfect animals will allow the heat of their blood to vary with that of the water in which they swim, or with the atmosphere, without this variation being productive of any sensible inconvenience to them, so long as the heat continued above the freezing point.

Although the blood is fluid when in circulation, it possesses the property in the living body of becoming solid, or coagulating, under certain circumstances. As this property of spontaneous coagulation is possessed only by one of the constituent parts of the blood, viz. the coagulable lymph, it will be more fully considered with that important part.

Our ideas of life are usually so much connected with organic structure, that it becomes at first very difficult to conceive that a fluid can be alive; it is therefore necessary here to consider what those properties are, in which life may be supposed to consist. There is no other mode of determining this, than by inquiring into what are the additional properties which an animal body possesses when said to be living, to what it does when said to be dead.

We can form no judgment of life but from its visible effects; for its causes are involved in so much mystery, and placed so far beyond the reach of human understanding, that our inquiries concerning them must be forever baffled, and rendered impotent. In this inquiry we have only to ascertain what are those additional properties which are common to every living animal, as these must be the properties essential to the simplest life. For different animals possess particular properties dependant on life materially different from each other, and some animals possess many more of these properties than others, or at least the same properties in very different degrees: for instance, man, the most perfect of all animals, possesses the powers of reason, understanding, and judgment, to a much greater degree; but these qualities, although they are certainly properties of life, are not essential to it; as animals do exist in which no traces of them are apparent.

Self preservation, or a power of resistance to the returning to its simple elements, is a property which must exist in every living animal; when life ceases, this power is lost. The most simple view of life, is to consider it as a power of self preservation, for as soon as life leaves an animal body, that body cannot preserve itself; but soon will begin to decay and putrify, and consequently to return to its constituent elements. This power of self-preservation cannot depend upon the anatomical, chemical or mechanical properties of the matter of which an animal body is composed; nor does it depend upon any known arrangement of these properties: for if it did, life should remain until the matter of which the body was composed had been destroyed or changed; this however is not the case. Besides the loss of the power of self preservation, the body, when dead, no longer possesses the power of beginning motion within itself. It does not lose the power of moving; but if external force is not applied, it will for ever remain motionless. The actions of the living body are mechanical; but the inherent power of beginning these actions is not so; it is a property depending upon life, and is not to be explained by any mechanical or chemical laws.

The first property, then, in which all living animals differ from dead ones, is the possession of the power of self preservation; the second property is the power of beginning action or motion spontaneously within themselves. The first of these properties seems to be more essential to life than the second. For the power of self preservation may exist without action; but action cannot originate if the power of self preservation is gone. We are obliged to John Hunter for many facts explanatory of this. An egg is known to possess the power of self preservation for weeks, even when exposed to a degree of heat in which all dead animal matter would putrify; and this power exists without any perceptible action in the egg. Should this egg be placed under the hen, it evolves another power, that of begining motion or action within itself, viz. the formation of the chick. But if its first property of life should be destroyed, that is, its power of self preservation, by an electric shock or other means, before it is placed under the hen; when so placed it will immediately become putrid.

Vital action may be suspended for a short time, and the power of self preservation may remain; as is the case in those persons who have continued in a trance or swoon for some hours; during the whole period of which, no pulse has been felt, no air respired, nor have any signs of vital action been apparent. Vital action, however, when it has once begun, cannot be suspended beyond a limited time without death being produced. Although an egg can preserve itself for weeks before it has been placed under a hen, or in an equal degree of heat to that of a hen; after it has been so placed, should it be removed from that heat for two or three hours, it will die and putrify. Action therefore having once begun is essential to life, as the power of self preservation can exist but for a very short time without it.

Any animal body resisting resolution into its simple elements, when placed in a state favourable to that resolution, and at the same time susceptible of an impression to begin action, may be considered as alive. The power of self preservation is absolutely necessary to constitute life; but action renders life more perfect.

In proportion as an animal becomes more perfect, its actions become more complicated; but these actions, however complicated, have all a dependance upon one another. It appears probable, until some action does commence in an animal body, that no waste takes place, and therefore no supplies are required. When action has begun, there must be some waste, and this will produce other actions to supply that waste. An egg before incubation has no supply, it neither increases or decreases in weight, nor does any alteration take place in it; but after the incubation, when the chick has begun to be formed, the white first, and then the yolk are taken into the stomach of the chick, they afford a supply for the waste which action produces, and become the means of enabling the chick to increase in size.

From no apparent action going on in a person when in a trance; food is not necessary to support life until the person recovers. Those animals which remain in a torpid state during the winter, do not in the whole of that period require food; but as soon as they leave the torpid state, a supply of food becomes necessary to support the actions which have then recommenced.

All animals possess some peculiar properties during life; or the same properties in different degrees; but every property which they do possess must be dependant on one or both of the two already mentioned. These, viz. the power of self preservation, and the power of beginning motion, are equally essential to all animals, from the lowest and most simple in construction, to the most complicated and perfect. An animal body, when possessed of the first of these properties, may be considered as alive; when possessed of both, its life has never been doubted.

Now to apply this to the blood. That the life of every part of the body depends on the blood cannot be doubted; for should the passage of the blood to any part of the body be stopped, that part will die: the blood therefore carries life to every part, and is certainly the principal cause of the support of life. It appears, from this, a matter of surprise that doubts should ever have been entertained of the blood itself, not being as much possessed of the principle of life as any other part of the body. By calling blood alive, it is not meant that it is organized, or that it possesses any connection with the sensitive principle. It is meant that blood in its natural state, while circulating in its vessels, and in some instances even when it has been extravasated into cavities in the living body, possesses the power of self preservation in an equal degree with the other parts of the body, and in that power, the life of a living animal may be considered to consist. Motion is not essentially necessary to life; in the egg before incubation we have a strong instance of vitality existing without motion; and although the blood is in constant motion, that motion is produced by the heart and other vessels.

It is by this property of life, viz. self preservation, that the blood is kept in a state of fluidity; for its fluidity cannot arise from the action of its containing vessels, or the velocity of its motion, as the blood has remained fluid for days in persons in trances, where, to all appearance, it was perfectly at rest, and no action of the vessels was going on. Even when out of its proper vessels, and accumulated in large quantities in different cavities of the body from the rupture of some vessel, and where it could have no motion depending on the vessels, blood has continued fluid for some weeks, and in that state has been absorbed.

The opinion that the power of preserving its fluidity is one of the properties added to the blood by life, is supported by the blood's coagulating when removed from its vessels, or after death, under the same chemical circumstances in which it remained fluid when the body was alive.

John Hunter's experiments have proved that life may and does exist in an animal substance which is fluid, which is not organized, and which possesses no sensation, viz. the yolk of an egg. When the chick is perfectly formed and hatched, the yolk is found to be sweet, although during the whole time of incubation it had been in a heat the most favourable to the production of putrefaction, and might have been in a considerable degree of heat for some days before it was placed under the hen. Should the vitality of the egg be destroyed, the yolk will immediately putrify.

If the blood was not alive, it should act on the solids in the same manner that other dead animal matter acts, it should produce irritation, inflammation and ulceration; but instead of doing this, it remains in the greatest harmony with the solids, and even undergoes some changes in certain diseases along with them: in inflammatory fever it coagulates more slowly, although the coagulum is eventually firmer. Also in local inflammation, before the constitution is materially affected, the blood which is drawn from the larger vessels of the inflamed part, will be disposed to form a buffy crust, while that which is drawn from vessels at a distance from the inflamed part will not have that disposition. In these inflammatory cases the blood appears to have its living principle increased in an equal degree with that of the rest of the body. In many putrid diseases, where the solids are verging towards putrefaction, the disposition of the blood to form a firm coagulum when drawn from its vessels is much lessened, as in putrid fever, scurvy, &c.

In deer, hares, and other animals which have been hunted to death, and in horses which have dropt down dead from having been over exerted, the blood does not coagulate.

It has also been discovered by the people employed at the victualling office, that if oxen are slaughtered immediately after having been driven from some distant county, the meat soon becomes putrid, and will not take the salt: the cattle therefore are fed and rested after their journey, before they are killed. In these cases, the blood not coagulating after death, is probably owing to its living principle having been exhausted by the fatigue which the animals experienced before death, in the same proportion in which the living principle of the other parts of their bodies was exhausted.

In cases where death takes place instantaneously from any cause, such as lightning, or sudden and violent fits of passion, the blood does not coagulate; does not this probably arise from the living principle so suddenly leaving it, the whole of the body being deprived of life at the same moment?

In the living body, blood thrown out of its vessels on surfaces, or into cavities, coagulates without losing its principle of life; for if we examine blood thus coagulated, after some little time, vessels from the surrounding parts will be found passing into it and ramifying through it. There are many of John Hunter's preparations exhibiting injected coagula, in the museum. That excellent physiologist, in some of these preparations, not being able to trace a direct continuation of ramifying arterial branches from the circumference of the living parts to the centre of the coagulum, although he found a series of injected vessels there, supposed that these vessels were formed *first* in the coagulum itself, and that they anastomosed with, and thus opened a communication with the vessels which shot into the coagulum, from the surfaces of the living parts in contact with it. This property of the coagulated blood will again be referred to when we are considering the qualities of the coagulable lymph. John Hunter thus gives to the blood not only the first property of life, viz. the power of self preservation, but also the second property, viz. the power of beginning action within itself.

The living power of the blood, while in a fluid state, appears to be no more than that of the simplest life, viz. the power of self preservation.

When it becomes solid, it then may open a communication with the mind. Solids have organization, and consequently can produce certain visible effects of life; but fluids not having organization, these effects cannot be produced by them.

The opinion of the blood being possessed of the living principle, although first brought into general notice by John Hunter, was undoubtedly entertained by others before his time. I shall pass over, as unsupported by any reasoning, the assertion in the bible, that, blood is the life of the animal, as it proves no more than that this was the opinion of the Hebrew lawgiver.

But in referring to the works of Harvey, you will find that this opinion was very firmly entertained by him; and I believe that he is the first person who has endeavoured to support this doctrine by argument and reasoning. He calls the blood the "Primum Vivens," and the "Ultimum Moriens" of the animal. And in many parts of that excellent work of his, De Generatione Animalium, are passages to be found, proving that he entertained this opinion to as great an extent as has since been contended for. In the beginning of his 52d exercitation, which has for its title, "De Sanguine, prout est pars principalis," after a few observations on the blood being first formed, he says: "Ideoque concludimus, sanguinem per se "vivere et nutriri, nulloque modo ab alia aliqua "corporis parte, vel priore, vel præstantiore de-"pendere."

LECTURE II.

ON THE PROPERTIES OF THE BLOOD WHEN OUT OF THE CIRCULATION.

Thus far the blood has been considered as a general mass of fluid, circulating in the vessels of a living animal; we are now to inquire what those properties are which belong to it, which can only be known by examining it when out of the circulation.

While blood is flowing from a vessel of a living animal, a thin vapour, or halitus, flies off from it; upon this being condensed, it has been found to be nearly as insipid as water, and in smell rather fœtid, something between that of sweat and urine. The fœtor is greater in carnivorous than in graminivorous animals.

Blood, when received into a vessel from a living animal coagulates, and separates into a fluid and a solid part.

When blood passes in a free stream into a basin, and is allowed to remain at rest, it begins to jelly or coagulate in three minutes and a half. A thin film appears first on the upper surface of the blood, and generally near to the edge of the vessel; this thickens gradually until the whole is coagulated; but the upper surface coagulates first. In blood taken from a healthy person, the coagulation is usually completed in seven minutes; and in twelve minutes (although it will sometimes take a longer period) the mass will be very firm.

Soon after this, a transparent watery part will be perceived transuding through the pores of the coagulum; the coagulum at the same time contracting itself, leaving the sides of the basin; but still preserving its original shape. The transparent watery part forms the serum. The coagulum retains the red colour, and forms the crassamentum. The crassamentum being the heaviest, sinks in the serum.

These two parts differ in the proportions they bear to each other in different people. In persons who enjoy a good natural state of health, they are nearly equal; the crassamentum being of the two in the larger proportion. It is evidently so in stout laborious people, and in some inflammatory diseases. In weak people, and in diseases of weakness, such as dropsies, the serum is in the largest proportion.

The coagulation and separation take place in any degree of heat between 38° and 108° of Farenheit's thermometer. Between 38° and 32° the blood will, in general, remain fluid; at 32° it will freeze.

The experiments made by Mr. Hewson, and those made by Mr. Hey, of Leeds, prove, that the coagulation and separation of the blood take place most readily when that fluid is kept in a temperature nearest to its standard heat, viz. 99°. It is therefore ascertained that cold does not produce the coagulation.

Nor does the coagulation depend merely upon exposure to air; for John Hunter found the blood to coagulate more readily when received in vacuo, than when exposed in open air. Blood also coagulates in the vessels of dead bodies, and when extravasated into cavities in living ones, where no air could reach it.

The coagulation of the blood does not depend upon rest: for agitating it, by stirring it constantly with a stick as it flows from the body into a basin, will not prevent it from coagulating; for it will coagulate and adhere firmly to the stick. The blood of people in trances also remains fluid.

In the bodies of persons who have died a natural death, the blood has been found to be coagulated in the large vessels, and in the heart. It has been already stated, that in the vessels of those who meet with a very sudden and immediate death, such as arises from strokes of lightning, or violent fits of passion, the blood remains fluid.

In people whose death, although not natural, is not immediate, as in strangulation, or where three or four minutes intervene between the first attack and death, the blood will, in the larger vessels, be found in a thickened state, but not firmly coagulated. I have always found it in this thickened state in the bodies of persons who have been executed.

We are, therefore, yet ignorant to what causes the spontaneous coagulation of the blood is attributable. Although we cannot form even a plausible conjecture as to the cause of this change, it is evidently dependant upon some alteration in the component parts of the blood, affecting their chemical composition; for blood before coagulation is wholly soluble in cold water, whereas, afterwards, a considerable portion of insoluble matter has made its appearance.

The serum is a fluid of a pale straw colour; it is somewhat viscid, and has a slight saline taste; it is about $\frac{1}{38}$ part heavier than water; its specific gravity to water varies in the proportion that something from 1020 to 1030 bears to 1000.

When the coagulum is firm, a greater proportion of serum is separated than when it is loose: this probably arises from its being squeezed out more forcibly by the contraction of the coagulum.

The coagulation of the blood is not always a necessary step to the separation of serum; for serum, or a fluid differing in no essential quality from it, is separated, and sometimes accumulated in large quantities in the circumscribed cavities of the living body, as the liquor pericardii, fluid of dropsies, &c.

Serum is readily soluble in all proportions of water, and to the delicate test of paper tinged with fresh violet juice it affords traces of an alkali.

When serum is exposed to any temperature above 160° it coagulates into a white tremulous mass (it sometimes has required 167° to coagulate it). This effect is rapidly produced by the sudden admixture of an equal quantity of boiling water; but if the serum be largely diluted with water, the solution is merely rendered turbid; and when the quantity of water is very considerably increased, heat produces no apparent change.

Dilute sulphuric, nitric, and muriatic acids, and alkohol, also coagulate serum.

The substance which thus coagulates upon the application of heat, of acids and alkohol, is found to possess the essential characteristic properties of white of eggs, and has been termed albumen.

The coagulation of albumen has been variously accounted for. It has been before stated that serum exhibits alkaline properties; white of eggs likewise contains an alkali, and in both cases it is found to be soda. Dr. Thompson ascribes its coagulation to a diminished affinity between the water and soda, and the albumen, which thus allows the cohesive force of the latter to act.

From the action of voltaic electricity upon albumen, and fluids containing it, it would appear that its evaporation depends upon the abstraction of alkali. Liquid albumen is a compound of albumen, soda and water. When heat is applied to it, the affinities existing between these bodies are modified; the alkali, before in chemical combination with the albumen, is transferred to the water, and the albumen assumes a solid form.

When the serum of the blood has been coagulated by heat, a very small quantity of viscid fluid oozes from it, which has been termed *serosity*. From the observations of De Haen, this fluid has been supposed to consist of gelatine; but, according to Dr. Bostock, it is mucus. It has just been stated, that the alkali is transferred during coagulation, from the albumen to the water. The aqueous alkaline solution thus formed, re-acts upon the albumen, and dissolves a little of it: this *solution* is the *serosity*.

The serosity, has been observed by John Hunter, to be in much larger quantity in animals come to their full growth, than in young animals; forming what in culinary language is termed gravy In dressed lamb or veal, there is little of this, but much jelly, which John Hunter supposes to be part of the meat itself dissolved in the serosity and water in which the meat was boiled. In beef or mutton there is a larger quantity.

The coagulation of albumen, by alkohol and by acids, may be explained upon the same principle; acids render it more rapidly and perfectly solid, on account of their superior affinity for the alkali.

The principal ingredient, then, in the serum of the blood is albumen, in the state of combination above noticed; besides which it contains, in solution, a little muriate of soda, phosphate of soda, and phosphate of lime.

There is also a quantity of water not combined with, but diffused through the serum. This redundant water, the late Dr. George Fordyce supposed, contained almost all the salts of the blood, and other occasional substances. This water varies in quantity, and may be separated from the serum in the living body, as is the case in certain secretions; but that which is chemically combined cannot be separated. The separation or addition of redundant water does not, therefore, affect the viscidity of the serum, so as to be of any consequence in the circulation. Could the water chemically combined with it be separated in the living body, this indeed would render the serum more viscid.

The natural colour of the serum has been supposed to be derived from the quantity of alkali found in it. This probably may be the case, although we are deficient in proof that it actually is so. The natural colour of the serum will be occasionally altered by substances dissolved in, or mixed with the water diffused through it, whether these substances are of use to the body or otherwise. Thus the bile in jaundice will give it a more yellow colour. It will also have a yellow colour in a person who has recently taken rhubarb. In blood taken from people who had lately eaten a hearty meal, the serum has been found to be of a muddy whey colour; this may have been produced by a mixture of the chyle with it.

The serum has sometimes been found of a white colour like cream, and to contain globules. This appearance also has been supposed to have arisen from the chyle mixing with the blood. It is not likely, however, that it should arise from such a cause; for when this appearance is met with, which is not often, it is usually in the serum of persons whose appetite has been bad, and who have been subject to sickness and vomiting: nor does it always take place after a hearty meal.

Mr. Hewson asserts, that he has frequently seen the serum of geese of this white colour, whereas their chyle is transparent. He supposed that it arose from absorbed fat. He inspissated some of this white serum to dryness, and compared it with the natural serum of the human blood prepared in the same way; he asserts that he found it to be much less tenacious and much more inflammable; and that when thus dried, its oil oozed out so as to make the paper in which it was kept greasy. He has also stated that all the people whose serum was white, whom he had seen, had some plethora, which was relieved by spontaneous hæmorrhage, or by blood-letting; and as fat is a nutritive substance laid in store by nature to nourish the body when food cannot be procured, or when the stomach cannot digest it; he supposes that when it is absorbed and carried to the blood, this appearance of white serum is produced.

John Hunter does not agree with Mr. Hewson in this supposition; but he does not determine what the white serum is owing to. In his experiments it did not burn greasy, but like to other serum. The white appearance, he says, evidently arose from globules not soluble in water, and which did not sink in the fluid, but swam on the surface. The serum, or rather the water diffused through it, is probably the solvent of all our secretions.

The crassamentum, besides a considerable proportion of serum, consists of two distinct substances: one of which gives it colour, and the other solidity.

The part which gives the colour may be separated from the rest, and has been found to consist of very small particles, which have generally been known by the name of red globules of the blood.

The part which remains consists of a tough, whitish substance, which becomes brittle when dry. This has been termed the coagulable lymph of the blood by some; gluten by others, and, within late years, by chemists fibrina.

On the Red Globules.

The globules not only give the red colour to the blood, but also, by means of the blood, to all the red parts of the body.

From the time of their first discovery they have been much attended to by anatomists; this has arisen from their having some form, and from the circulation of the blood having been more distinctly seen by their means.

We are indebted to the microscope for our knowledge of this part of the blood; but the globules may be seen by a common magnifying glass swimming in the serum and lymph of the blood. They are mechanically mixed with the other parts, and may easily be separated from them.

Malpighi was the first discoverer of the globules. He, Leuwenhoeck, De la Torre, Hewson, and others, have described their figure, size and other properties, as they appeared to them in the microscope; but they do not agree in the opinions they have formed concerning them. Observation of very minute parts in this instrument is constantly liable to some fallacy, from the difficulty of distinguishing real appearances from those produced by microscopical deception.

Their shape has generally been considered as spherical. Dr. William Hunter conceived them to be spheres a little flattened. Mr. Hewson has asserted that they are not spheres; but flattened vesicles shaped like a counter, or piece of money; he says, that he has frequently seen them turn over, and present all the phases that a circular flat body would do when in motion; he even goes farther, for he states, that he has sometimes seen them not only flat, but bent like a crooked piece of money: he therefore substituted the term particles for globules, as affording a more accurate and appropriate designation of them. The Padre de la Torre considered them as rings. A further attention to the abberration of the rays of light has explained these different appearances, under which the globules of blood have been represented. When viewed under a microscope of great magnifying power, while circulating in the vessels of animals that will admit of such examination, the globules appear occasionally to become elliptical, so as to adapt themselves better to the cavity of a smaller vessel, and appear sometimes flattened as well as oblong. They therefore seem to possess flexible and ductile properties. In some animals they are always of an elliptical shape.

When a single globule is viewed, it is transparent, when a few are collected together they have a yellowish hue, and it is only when several are clustered, that they appear to be red. In some vessels of the human body the globules are of a florid scarlet colour; in others of the modena red: this does not arise from dilution; for deep scarlet will not form modena red; nor will a light shade of modena red form scarlet.

The colour of the globules in and out of the body is affected by air: for venous blood, which is dark, received in vacuo remains of a dark colour; when air is admitted, it becomes bright. Air injected into a vein where blood has been confined between two ligatures will change the colour from dark red to florid scarlet. The colour of extracted venous blood is florid on the upper surface of the crassamentum, and on the under surface nearly black; changing the surfaces by inverting the crassamentum, will produce a change of colour; and this cannot arise from the gravitation of particles, for the lymph is coagulated much too firmly to admit of this The former under part, when placed uppermost, shall even become more florid, than the former upper part had at any time been, from more globules having been arrested in that part as they subsided during the coagulation of the lymph.

An experiment, made by John Hunter, has proved that the change of colour in the globules, during the blood's circulation through the lungs, arises from the air received into that organ. He fixed the pipe of a bellows, made in a particular way for the purpose, in the trachea of a dog; then having removed the sternum and cartilages of the ribs, and opened the pericardium, he imitated respiration, the bellows being so constructed as to throw in air and withdraw it; while he continued this artificial breathing the blood in the pulmonary veins became florid and dark, in the proportion he threw air or not into the lungs.

The change of colour from dark to the florid scarlet in the lungs, only proves that the blood has been exposed to air, which will change it either in or out of the body; too much importance should not be attached, therefore, merely to the change of colour: it is possible that the effect of supporting respiration may be the greatest on the other parts of the blood, for respiration is found to be as essential to the existence of those animals which have no red globules, as of those which possess them. The globules in passing from the arteries of the body to the veins, lose the scarlet colour, and become dark.

Some celebrated chemists have supposed that the red colour of the globules depended on the oxygene in our atmospheric air acting on the iron, which, they said, was found by chemical analysis in the globules: the oxygene, which was absorbed in respiration meeting with this iron, reduced it to a red oxyde.

Professor Brande, to whose friendship I have been often indebted for information on animal chemistry, has tried in various ways to detect iron in the colouring part of the blood; but has always found the traces of that metal indistinct. In making experiments with the above view, he discovered, that water, which John Hunter and others supposed had the immediate effect of dissolving the globules, dissolved only their colouring matter, the globules themselves remaining, but colourless. This aqueous solution is of a bright red, and not very prone to putrefaction; but the professor has not yet, I believe, made out the particular nature of the colouring matter.

When the blood becomes putrid, the globules have been found by the microscope to break down into a number of irregular pieces; the fluid then is muddy and not transparent.

(When the microscope is to be used for the purpose of viewing the globules, the blood should be put on a plate of glass forming a gently inclined plane; and should be diluted with serum, not with water, as water removes the colouring matter.)

Sir Everard Home has stated, in a paper published in the Philosophical Transactions of last year, from some experiments made on the globules by Mr. Bauer and himself, that the colouring substance appears not to be contained in the globules, but only to envelope them, and is easily to be separated from them; that the separation is very rapidly effected; the colouring substance flowing from all parts of the globule at the same instant; and that to retain the globules in the coloured state, it is necessary that a very small quantity of blood only be smeared as thinly as possible upon the glass, in order that all moisture may instantly evaporate, they then retain their full size and colour. But if a greater quantity of blood be laid upon a glass which retains moisture only half a minute, the colouring matter begins in a few seconds to separate, and form a circle round the globule, and if the blood is diluted with water, the separation of the colouring matter is instantaneous.

The size of the globules has been very differently estimated. They are found to be of different sizes in animals of different species; but nearly of the same size in all animals of the same species. Their size does not depend upon the bulk of the animal, for they are nearly of the same size in the ox, ass, cat, and mouse. In porpoises, men, dogs, and rabbits, they are nearly of the same size. In most fish they are larger than in men. They are still larger in frogs, turtles, and vipers, and in the skate they are supposed to be larger than in any other animal.

Leuwenhoeck has estimated the size of a globule of human blood at the $\frac{1}{25000}$ part of a grain of sand; this far exceeds any idea that the human mind can understand of their minuteness.

Jurin makes their diameter to be $\frac{1}{1940}$ part of an inch; Hales, $\frac{1}{3240}$; Haller, $\frac{1}{5000}$; Dr. Woolaston, $\frac{1}{4900}$; and Dr. Young, $\frac{1}{4416}$ part of an inch.

Mr. Bauer, attending to the size of the globules, at Sir Everard Home's desire, when invested with their colouring matter, and measuring them in the microscope by a micrometer, made each globule to be $\frac{1}{1700}$ part of an inch in diameter, requiring 2,890,000 to a superficial or square inch. When deprived of its colouring matter, each globule appeared to be $\frac{1}{2000}$ part of an inch in diameter, which makes 4,000,000 of globules to a square inch. From these observations it appeared, that globules deprived of their colouring matter, are not quite one-fifth smaller.

But it having been remarked that no spherical bodies could be accurately measured by a common micrometer, and therefore that no correct idea of the diameter of a globule of blood could be obtained by that means, Sir E. Home requested Captain Kater to measure them, in what appeared to him, the most satisfactory manner. The result was, that $\frac{1}{5000}$ part of an inch may be considered as about the mean diameter of the globule of human blood. The measurements of Baron Haller, Dr. Woolaston, and Dr. Young, nearly correspond with this.

The anatomists who first attended to the globules in the microscope, entertained most strange ideas as to their structure; and many absurd theories, as to use, were founded upon a structure existing only in their imagination. With these theories we now have nothing to do.

We do not know what is the real structure of a globule, nor how its structure can ever be ascertained. To the touch the globules yield no feeling of solidity, and while circulating in the blood-vessels they may be seen occasionally to assume an elliptical form.

John Hunter considered them to be a fluid, with an attraction to themselves while in the serum, yet without the power of uniting to one another.

They certainly have a determined shape and size in animals of the same species, and when swimming in the serum, they remain unaltered; they do not run into one another, as oil does after it has been divided into small globules in water; their form therefore, does not arise simply from their not uniting with serum.

They are not oily, for they sink in serum. When dried, they are not greasy, and when burnt, they are not more inflammable than inspissated serum, or dried coagulable lymph.

They have a slightly sweetish taste, and are inodorous. (If it should be wished to make experiments on the globules separately, they may be obtained by shaking the crassamentum in the serum, so as to diffuse the globules through it, and then pouring off the serum when they have subsided to the bottom of the vessel.)

The specific gravity of the red globules is greater than that of the serum and coagulable lymph; for when blood is prevented from coagulating, they subside to the bottom of the containing vessel; but, according to Dr. Young's experience, when the colouring matter is dissolved by water, the globules remain colourless, floating upon the surface; the colouring matter, therefore, appears to give them their greater comparative weight.

The globules are generally entangled in the coagulation of the lymph; but the undermost part of the crassamentum has the greatest number. In an experiment which I have seen repeated more than once, it has been found, that a portion of coagulated lymph, without any globules entangled in it, and another portion with the red globules entangled, being placed in the same serum, both will subside; but that with the globules will subside the soonest. The globules, therefore, form the heaviest part of the blood, while they continue to possess their colouring envelope.

Their proportion, in respect to the other parts of the blood, cannot be ascertained with any precision; it must vary at different times.

Whatever may be the use of the globules when divested of their colouring material, while possessing it, their use does not seem to be so great as that of the other parts of the blood. For animals having the other parts of the blood, exist without having *red* globules. In animals which possess them, they are not pushed into the extreme arteries. In some animals, red globules are not circulated in parts forming a very large proportion of the animal's bulk; in many large fish, the muscles are perfectly white. When much blood has been lost, they are not renewed so soon as the other parts; so that the animal for a time looks pale. They do not seem to be formed so soon as the other parts; for in the chick, the heart may be seen beating, at a time when it only contains transparent blood. They appear to be somewhat connected with strength and exercise; all strong animals having more than weak, and wild animals more than tame.

Sir Everard Home has remarked that while the globules are enveloped in their colouring matter, they are not seen to run together, and coalesce with one another on the field of the microscope; but when they lose the colouring matter, they continue floating in the serum, and are seen to have an attraction towards one another so as to coalesce, uniting themselves together. He has, in a paper published in the Philosophical Transactions, given plates of their appearance in doing this, forming in lines. Sir Everard Home has also delineated, in these plates, the appearance of an ultimate muscular fibre, as viewed in the microscope by him and Mr. Bauer; it appears to be composed of a string of vesicles, of the exact size of the globules of blood.

These gentlemen also discovered that when muscular fibres were macerated for a longer time than a week, they were readily broken down into a mass of globules of the size of those of the blood, and this appearance, joined to other circumstances, renders it probable at least, (Sir E. Home supposes) that the globules may be the part of the blood out of which the muscular fibres are principally formed.

This is certainly an ingenious, and far from being an improbable supposition; the fact is not yet proved, but there are some indirect evidences of its being well founded.

The enveloping colouring matter may be thus given to the globules for the purpose of keeping them separate in the blood vessels where their coalescence could be of no use. In the secerning branches of the arteries, from the smallness of the vessels and their orifices, or some other cause, the red envelope may be separated from the globules, and the globules being poured out singly, and in succession, they may thus unite and produce the muscular fibres.

This suggests grounds for future inquiry, whether on the separation of the red envelopes from the globules, the matter forming them being passed on with the blood into the veins, may not contribute to produce the altered colour of the blood in that set of vessels, and whether Hewson's vague opinions of the formation of the globules, though not supported by him either by facts or experiments, may not, from the subject being prosecuted as to the formation of the red envelope, lead to some important discovery.

The prosecution of this subject may even throw more light upon the action of respiration: at present however all this must rest as mere conjecture.

Hewson states that the blood in insects possesses globules, that in some they are white, in others of a faint green. That he has seen them in an insect the whole of whose bulk was not larger than a pin's head. He therefore supposes that they exist almost universally throughout the animal kingdom.

On the Coagulable Lymph.

The coagulable lymph, gluten, or fibrina, I have already stated, is the part which gives firmness to the crassamentum. When it is coagulated, and deprived of the red globules, it is white and almost colourless, and, after its coagulation, when, it has contracted and squeezed out the serum, or when the serum has been pressed out by artificial means, it is very tough and elastic; its degree of toughness being in proportion as it is free from serum; it then, not only appears to be fibrous, but even in many instances it is formed into laminæ.

The contraction of the coagulum is continued for a long period after coagulation has taken place, sometimes for days; the coagulated part becoming less, as more of the serum is squeezed out. This, John Hunter observes, cannot arise from the serum being lighter, and issuing out spontaneously; for without some expelling force, it would be retained mechanically, by the capillary attraction, as in a sponge.

The coagulable lymph is fluid while circulating in the vessels of the living body; but when out of the vessels, it coagulates almost immediately, and does so whether the blood is agitated or kept at rest. The remarks which have been already made on the spontaneous coagulation of the blood, apply exclusively to this substance.

In the circulation, the coagulable lymph is mixed with the serum and water, and cannot be separated from the serum by any artificial means, while both are fluid. It may however be separated by the action of the blood vessels, and is so separated in inflammation, and deposited in cells or on surfaces. By the same means, the serum can be separated from the coagulable lymph, and on being deposited in cavities, produce dropsies. In coagulating, after the blood has been drawn from vessels, it usually entangles the red globules with it. It is found to coagulate sooner under some circumstances than others; such is the case when the blood is drawn through a small orifice, when it is allowed to run down the arm, and when it is received into a flat or angular vessel.

It does not coagulate so soon in cases where the arteries are acting strongly, as in extensive or violent inflammations.

It will coagulate when blood, in a vessel in the living body, is confined between two ligatures; but in this case, it requires a longer time, and the smaller the vessel is, the longer will be the time required; in experiments made to ascertain this, it took three hours and more.

The whole mass of blood appears to coagulate immediately, when it is exposed, as soon as it leaves its vessels to 125° of heat; but it is the lymph only which actually coagulates; for the serum requires 160° to fix it. The exact degree of heat required for the coagulation of the lymph is not precisely ascertained; we may from analogy infer, however, that it is one between 116° and 125°.

The lymph coagulates also immediately on the application of æther, alkohol, acids, or alum; but none of these can, in the living body, be applied in a sufficient degree of strength to coagulate it, unless an opening is made into a blood vessel, and these substances thrown in.

The coagulable lymph, in its dry state, possesses the chemical properties of dried coagulated albumen. It is insoluble in cold water, and nearly so in hot water. The alkalies dissolve it, forming a dark brown or olive coloured saponaceous compound; from which it is again separable, in a somewhat altered state, by an acid.

Sulphuric acid decomposes it, and a large portion of carbon is separated. Nitric acid diluted with water, applied to it, disengages nitrogene, and converts it into a substance resembling gelatine. (Vide Hatchet. Phil. Trans. 1800.)

When coagulable lymph is acted on by boiling nitric acid, a fatty matter is formed which swims upon the surface, and a large portion is dissolved; the solution has the principal properties of a solution of albumen. During the action of nitric acid, prussic acid, carbonic acid, and nitrous gas are evolved, and oxalic acid remains in solution. (Vide Thompson's System of Chemistry.)

The lymph may be prevented from coagulating by the immediate admixture of neutral salts; as by receiving the blood into a basin or other vessel, in which there are salts, and agitating them together; in this manner blood is kept fluid by people, for culinary purposes.

Although some of these salts keep the blood fluid, yet, on twice its quantity of water being added, the blood will then coagulate; this is the case when sulphate of soda is used.

When the blood has been kept fluid by the sulphate of soda, the red particles will readily subside, and the surface of the mixture will be clear and colourless; this will be found to contain the coagulable lymph; for on the addition of twice the blood's quantity of water, the lymph will coagulate, and upon shaking the coagulum, it will be broken, and will fall to the bottom.

There are many salts which will keep the blood fluid, and not allow it to coagulate by the addition of water: such are, the sulphate of potash, the sulphate of magnesia, the muriate of ammonia, and the nitrate of potash.

It is well known, that in inflammatory disorders, where the arteries are acting very strongly, upon blood being taken from the patient, and allowed to remain at rest in any temperature between 40° and 100°, the upper part of the crassamentum shall be of a bluish white appearance, firm in its texture, and of a hollow or cup-like form on its surface. The red globules are generally entangled in the lower part; but on some occasions, the whole of the crassamentum shall be without them; in which case, the globules will be found loose and disentangled at the bottom of the vessel.

This crust of size or buff, as it has been termed, is of different degrees of thickness; the thickness depending on the length of time which intervened before the lymph coagulated: for size is never found when the blood coagulates quickly. The time for producing it may vary from five minutes to an hour and a half; the size or buff being merely the lymph coagulated, after the red particles had subsided some way towards the bottom of the vessel.

Blood, in inflammatory cases, is not only longer in coagulating, but it is also, under such circumstances, actually thinner; and this thinness is proved, by some experiments of Mr. Hewson, to depend upon the greater attenuation of the lymph.

The sizy appearance of the blood is not confined, however, to cases of inflammation; it is often met with in the advanced stages of pregnancy; it is, in fact, met with in all cases where some great and increased action of the arterial system is going on; but even in the most inflammatory cases, some accidental cause may prevent this appearance, as any of those circumstances occurring which dispose the blood to coagulate more quickly.

Strong action of the vessels appears to dispose the blood to coagulate more slowly: while fainting or diminished action, disposes it to coagulate more quickly. We find, in an animal dying from the loss of blood, that the disposition for this fluid to coagulate becomes greater in proportion as the animal grows weaker. When the animal is extremely weak, the blood withdrawn coagulates almost instantaneously, and through the whole mass at once: before the animal becomes weak, the blood first coagulates upon the surface, and afterwards more deeply.

Instances have been met with, where the serum, and a part of the coagulable lymph, in a fluid state, have been contained in a bag formed by the remainder of the lymph, which had coagulated where it was in contact with the surface of the containing vessel, and with air; upon the bag being perforated, and the fluid let out and exposed to air, the lymph has coagulated. In other instances, the lymph has coagulated so completely as to form a bag, containing the whole of the serum.

It is impossible to determine what are all the various uses of the coagulable lymph, or any of the other component parts of the blood; but we cannot doubt of the coagulable lymph having most important uses; for it is a part found in the blood of all animals, and undergoes certain changes, which are necessary to the growth and preservation of every animal. When the lymph is out of the circulation, as when blood is received in a vessel, or otherwise detached from the body, its coagulation would seem to be unconnected with life; yet life could not continue without this effect taking place; as the solid parts seem to be formed and supported by this property, and hæmorrhages of the most alarming nature occasionally stopped by it. All this proves that coagulation is the most important property of the blood. John Hunter has expressed his opinion, on this subject, in very clear and forcible language: he says, " It appears

" to me to be evident, that its fluidity, (viz. the " blood's) is only intended for its motion; and its " motion is only to convey life and living materials " to every part of the body. These materials when " carried, become solid; so that solidity is the " ultimate end of the blood, as blood."

By this property it becomes the bond of union between divided parts; it is thrown out on the newly-made surfaces, and adheres to them; vessels from these surfaces, shoot into and through it, and every where unite and inosculate with one another.

By the property of coagulation, blood is also concerned in the formation of granulations to supply the loss of removed parts: the coagulable lymph being first deposited by the secerning arterial branches, and these, or other vessels from the same trunks, then, entering the coagulum, and ramifying in it.

Under particular and necessary circumstances John Hunter believes that a coagulum has the power to form vessels in, and of itself. He says, that he thinks he has been able to inject what he suspected to be the beginning of a vascular formation in a coagulum, when it could not derive any vessels from the surrounding parts; and instances the injecting the crural artery of a stump, above the knee, where there was a small pyramidal coagulum; he filled this coagulum with injection, as if it had been cellular; but there was no regular structure of vessels.

He compared this appearance, with that of many violent inflammations on surfaces where the red blood is extravasated, forming, as it were, specks of extravasation like stars; and which, when injected, produced the same appearance he had met with in the coagulum. He compared these again with the progress of vascularity in the membranes of the chick, where a zone of specks can be perceived beyond the surface of regular vessels close to the chick, similar to the above extravasation, and which in a few hours became vascular; and from these circumstances he conceived that all these parts had a power of forming vessels within themselves, all of them acting upon the same principle.

Whether vessels shoot into the coagulum from surrounding surfaces, or whether they first form in it, or both; these vessels, when they meet in the coagulum instantly unite or inosculate; the coagulum being thus organized, nerves afterwards shoot into it, and open a communication with the mind.

I have frequently filled with injection vessels ramifying in coagulable lymph deposited by the action of the living arteries on inflamed surfaces, and have, in more than one or two instances, examined the appearance in a microscope of considerable magnifying power. In one instance, where the disease, so far as it could be judged of from symptoms, had not exceeded two days in duration when the person died, a quantity of coagulable lymph was deposited on the surface of the heart, I threw size coloured with vermilion into the coronary arteries, and thus injected the substance of the heart, and in many places the coagulable lymph. In one part a small projection of the coagulable lymph appeared more vascular than the rest; on a section being made of this part and submitted to the microscope, arteries from the pericardial coat of the heart were found to have entered the coagulated lymph at three or four places, and to have shot out branches which approached each other, and took a more oblique course to the surface of the coagulum; some irregularly shaped cavities were also filled with injection, which I then conceived arose from extravasation.

In another instance, I injected the uterus of a person where two corpora lutea had formed in one ovarium, and who, being unmarried, was supposed to have destroyed herself in consequence of being pregnant; the decidua adhering to the inner surface of the uterus was found to be highly injected, and, on the parts being inspected in the microscope, vessels were seen in great abundance entering the decidua, and branching off obliquely towards the surface. No irregular cavities were perceptible.

The decidua is an efflorescence from the inner surface of the uterus, and at its first formation resembles exactly an exudation of coagulable lymph. (The preparation of the parts is preserved, and is now in the collection in Great Windmill Street.)

I had, previously to this, injected a uterus, brought to me for that purpose by Mr. Richard Ogle; he afterwards presented it to John Hunter, and it is preserved in the museum of our college. John Hunter has, in his treatise on the blood, given a figure, in one of the plates, of this injected uterus of its natural size, and another figure of a section of it as it appeared when magnified in the microscope, in which vessels are delineated which were seen to enter the decidua from the uterus, and to ramify in it. A description of the uterus, by Sir Everard Home, has been published in the transactions of a society for the improvement of medical and chirurgical knowledge.

The vascularity of deposited coagulable lymph, is most satisfactorily and beautifully seen in many of the preparations made by John Hunter, and preserved in this museum.

Some recent discoveries made by Sir Everard Home, which have been published in the Philosophical Transactions of last year, throw much light on, and indeed seem to explain the appearances which John Hunter met with in the injected coagulum, so far as they regard, what he called, its cellular structure.

From a hint, which Sir Everard Home says he received from Mr. Bauer, respecting a process which that gentleman had discovered as taking place in growing vegetables, he requested his assistance in making some observations on the mode of the coagulable lymph becoming vascular when extravasated; Professor Brande's assistance was also called in, and from his experiments it was discovered, that the blood, while circulating in its vessels, possessed a considerable quantity of gas in solution. It was ascertained that this was carbonic acid gas; and that it was met with, in the same proportion, in arterial and venous blood; also that two cubic inches were extricated from every ounce of blood. It was also discovered, that a considerable portion of this carbonic acid gas was extricated from the blood during its spontaneous coagulation. This being known, a small quantity of human blood was, while in a fluid state, received into a watch glass, and placed immediately in the field of the microscope; the eye was kept constantly fixed on it, to observe the changes that might take place. In about five minutes, something was seen to be disengaged in different parts of the coagulum, and passing with considerable rapidity through the serum; and wherever this extricated matter was carried, a net work immediately formed, anastomosing with itself on every side through every part of the coagulum.

When blood drawn from the arm was placed under the receiver of an air pump, and the air extracted by immediate exhaustion, no appearance of a net work took place when the blood coagulated.

When extravasation and coagulation of blood take place, from whatever cause, in living animals, and this net work is formed in the coagulum, no difficulty, Sir Everard Home infers, remains in accounting for it afterwards becoming vascular, since all that is necessary for that purpose is, the red blood being received into the channels of which this net work is formed. This is an ingenious conjecture; but still it remains to be accounted for, how these cavities obtain coats similar to the arteries, possessing muscular fibres, vasa vasorum and nerves.

Sir Everard Home, prosecuting this interesting subject, next attempted to inject the net work in the coagulum, and has presented the preparations shewing the result to our museum.

I have thus given some account of the known properties of the most important fluid in an animal body. The idea formerly entertained of the blood which was sent to glands having different secretions, being possessed of different properties, is, I believe, universally given up. The only difference arterial blood can have, is that which will arise from a greater slowness of motion; and this difference (in those arteries where it may take place) is scarcely observable so as to be satisfactorily proved by any experiment; and we know only of one secretion which takes place from venous blood, viz the bile.

The blood of animals of the same genus is very much alike; the only known difference, in any animal, being in that part which gives to the blood its colour.

The experiments which have been made by transfusing the blood of one animal into the vessels of another, strongly prove the uniform nature of this fluid; for, excepting the symptoms that might arise from opening into, and placing tubes in the cavities of the blood vessels, no particular alteration has been observed, although the principal part of the blood of one animal has been conveyed into the system of another whose natural habits were completely different.

Different substances may be mixed with the blood, and some are dissolved in it; but these substances are not chemically combined with it, they are only diffused through it; were they so combined, the nature of the blood itself would be altered, and the uniformity I have mentioned in blood, could not so universally exist. Instances of bile, madder, indigo, musk, and the odorous part of many vegetables being found under particular circumstances in the blood, will occur to the recollection of most men who have attended to the nature of this fluid; but these substances are conveyed into it by the absorbents which had removed them from parts where their accumulation would be prejudicial to health, that they might be sent to those structures which had the power of separating them from the mass of blood, and ejecting them from the body.

John Hunter relates an instance in a house painter who worked with lead, where so much of that mineral had been absorbed as to produce paralysis of the extremities during life, and also, as was proved by dissection after death, to have altered the chemical properties of some of the solids; for the paralytic muscles had not only lost their natural colour, as happens in common paralysis, but were opaque, resembling exactly parts steeped in a solution of Gowlard's extract, appearing as if the lead had been carried along with the blood, even into the muscles themselves.

It was a very natural thought, after the discovery of the circulation had proved that a single globule of blood would pass over the whole body, that medicines infused into the blood vessels would prove a more ready and efficacious application to an unhealthy part, than could be obtained by taking them into the stomach, where they must first be mixed with the chyle, and absorbed with it, before they could be brought into the constitution.

Many anatomists and physiologists, therefore, amused themselves by injecting different substances into the vessels of animals to prove their effect. But the infusing medicines into the blood was soon discontinued, from the sometimes fatal inflammation which succeeded the opening a vein and inserting a pipe into it, as well as from another cause, viz. that many substances, completely inoffensive when taken into the system in the common way, proved, when injected directly into the blood vessels, fatal to the animal. It has been ascertained by repeated experiments, that atmospheric air injected into the jugular vein of a horse, will almost immediately destroy the life of the animal.

I have dwelt longer on the properties of the blood than I originally intended, but I trust the importance of the subject will not plead in vain for my excuse.

LECTURE III.

ON MUSCULAR FIBRES.

Muscular Fibres form so large a proportion of the substance of animals, are so curious in their structure, and answer so many important purposes in the animal economy, that their nature and properties have always employed much of the enquiry of anatomists and physiologists.

By the action of these fibres in moving the body from place to place, animals are distinguished from vegetables. Some vegetable bodies indeed possess motion, but we are not sufficiently acquainted with the structure of their moving parts, to ascertain whether it is at all dependant on muscularity. The Mimosa, Dionæa Muscipula, Enthroneum Cerolodendrum, and some other plants, afford instances of motion in vegetables.

In mankind, not only speech, loco motion, and all the arts subservient to the support, the comforts, and elegancies of life, depend on muscular action; but by it the circulation of the blood is carried on; so are the functions of respiration, digestion, absorption, the peristaltic motion of the alimentary canal the whole in short of the motions of the body, even those on which life immediately depends.

It was not my intention, when I first proposed to make muscular fibres the subject of our consideration, to have entered farther into their nature and effects, than what immediately concerned the action of the heart, and other parts of the vascular system; but I soon found it very difficult to determine what circumstances respecting muscular motion could, with propriety, be omitted, for in fact, limited as our knowledge is of this important action, it still must be considered as the foundation of most of our physiological science. I have therefore made the following observations apply to muscular action generally, and have endeavoured to be as concise in presenting them to this audience as the nature of the subject would permit.

MUSCLES are those organs which produce the several motions of the body, by contracting their length, and thereby bringing the parts to which they are affixed nearer together.

There is a power in the living body, by which several parts of it are capable of beginning and carrying on motion without any external application of mechanic force. This original power of motion is not found in every part, so far as regards the motion of the mass of the part; neither bone, cartilage, ligament, tendon, or membrane possess it, but it is found in the structure of the vessels which supply those parts with blood.

Fibres, of a particular nature and arrangement, are met with in most parts possessed of this power, which are called muscular. They probably are present in every part endowed with it, although they may be too minute to admit of demonstration. In the large blood vessels they are evident, though not visible, in the smallest branches; but from analogy we may fairly infer their existence there.

The parts into the construction of which these fibres enter are called moving parts.

Several of these fibres, collected into packets connected to each other by cellular membrane, form a muscle. A muscle thus consists of a fibrous substance capable of contraction and relaxation; it consists also of the ramifications of arteries, veins, absorbents, and nerves, bound together, and connected to other parts by cellular membrane.

The colour of a muscle in the human body is red; but redness of colour is not essential to the constituent fibres, for in the coats of an artery these fibres are of a yellowish white colour; and in many fish they are perfectly white. The redness in the muscles of the human body is dependant on their degree of vascularity; the fibres themselves are similar in colour to the lymph of the blood when coagulated and deprived of the red globules; for if the blood is washed out of the vessels of the muscles, their contractile fibres then appear of a yellowish white colour.

Much uncertainty prevails concerning the particular structure of these fibres. In every muscle we meet with long, soft, and somewhat extensible fibres capable of contraction, and which generally are disposed in packets parallel to each other. The cellular membrane is employed to connect many fibres so as to form a small packet or bundle; these bundles are connected to each other by coarser cellular membrane, so as to form fasciculi of larger size; these again by more loose cellular membrane into still larger fasciculi, which are applied laterally to each other, and the whole, including the vessels and nerves, covered by a coat of cellular membrane bounding the entire muscle. The fasciculi, as well as the cellular membrane, are coarser in some muscles than in others, as in the deltoid muscle when compared with those of the eye.

Wherever strength is wanted the fibres of muscles put on a coarse appearance; but where variety and accuracy of motion are required, they are finer and more delicate.

This fibrous appearance and structure is less marked in some animals than in others; indeed in some animals, as in the hydatid, it cannot be at all observed. When that which appears to be a single fibre to the naked eye, is viewed in a microscope, it seems to be composed of lesser fibres, but which are too minute to have their structure ascertained with accuracy; forms, therefore, have been ascribed to them, according as the mind of the observer was prepossessed with any particular theory respecting the mode of their producing action.

Some physiologists have described the minute structure of muscular fibres as consisting of cells; others of hollow tubes; others of strings of vesicles; others of rhomboidal articulations.

I have already stated that Sir Everard Home and Mr. Bauer, who have lately viewed them with great attention in the microscope, have described them as consisting of chains of vesicles nearly similar in size to the globules of the blood when deprived of their colouring investing matter, and have thought it probable, that they were formed by the globules connecting themselves together in straight lines.

Muscular fibres, when alive and in their natural state, possess a power of beginning an action when certain stimuli have been applied to them; but which stimuli act by a power totally distinct from mechanic force. This action consists in the fibres shortening, or in their endeavour to shorten themselves; for they often act as strongly in their endeavour to shorten (and indeed more so in some instances,) than is required of them to actually shorten themselves in ordinary cases: as in endeavouring to bend the arm, when the flexion is prevented by some accidental obstacle, or other opposing power. The fibres may even be lengthened, and still be in action, as when a stronger person pulls the arm of a weaker who resists; in this case the fibres of the muscles of the weaker person may be lengthened by superior force, notwithstanding they are endeavouring to contract or shorten themselves.

Muscular fibres do not acquire this action in consequence of motion being communicated to them by any external agent; it is an innate action arising in themselves, and is so far essentially different from any action taking place out of an animal body.

This action is not owing to mechanical impulse; for it is obvious that the impulse, which sets any inanimate machine to work, cannot originate in the machine itself. Muscular motion is an original principle; mechanism is only a second principle; for the most simple or the most complicated inanimate machine must remain for ever at rest, unless some power, not originating in itself, is applied to give and to keep it in motion.

If one ivory ball is struck against another, a certain quantity of motion is communicated from the one to the other; but the quantity which is acquired by the second ball, is only that which has been lost by the first, and did not originate in either, but in the muscles of the striker's arm. But if the muscles of a living animal are laid bare, and irritation applied to them, such as pricking them with a pin, they will be excited to contraction; this contraction, however, will not depend on any motion being communicated by the pin, it is merely the effect of the point of the pin exciting the muscles to an action that is resident in their constituent fibres.

This action is also materially different from elasticity, a property possessed by many parts of an animal body; for muscular fibres can act without being previously acted on; this elastic bodies cannot do.

When the action of living muscular fibres ceases, the fibres are then said to be relaxed.

Muscular fibres, when in action, become immediately much firmer, and harder in their substance, and if not counteracted by some resistance which they cannot overcome, they also become shorter, and run into the straightest line between their extremities, and retain that with force. They are likewise increased in thickness.

The degree of hardness in muscular fibres, is in proportion to the force which they are obliged to exert. The degrees of shortness and thickness are in proportion, to that force, and the resistance they meet with, i. e. whether they are allowed their full scope of contraction or not. There is therefore, much difference in the degrees of hardness, thickness, and shortness, viz. all between the full state of contraction, and the greatest degree of relaxation.

Muscular fibres are capable of much greater degrees of contraction from certain stimuli, than from others: thus a common idea of the mind, cannot produce that great contraction, which takes place in spasm. The muscular fibres of a maniac are found frequently to be possessed of a much stronger degree of contraction, than those belonging to a person in health, and of a much larger, and more robust appearance.

However strongly the muscular fibres may be contracted, the tendon belonging to them undergoes no change; (a tendon is only a strong cord, taking up little space from its bulk, joining the muscular fibres to, and allowing them to act on parts situated at a distance.)

As far as it has yet been ascertained by experiments, there is no difference produced by a state of action, in the real bulk, or in the density of muscular fibres.

One might naturally suppose, that as muscles become harder in their contraction, the minuter parts of which they are composed, must be drawn nearer each other; so that there must be a greater quantity of fibres in a given space than when the muscles are relaxed. We must therefore here recollect, that they possess also, in action, a lateral swelling, or increase of thickness, which may compensate for what is lost in length.

Some experiments made by Sir Gilbert Blane, and published in the Philosophical Transactions of 1788, prove sufficiently, that there is no difference either in the density, or the specific gravity of equal bulks of contracted and relaxed muscular fibres. Experiments have also been made by John Hunter and others, proving these facts.

One purpose in nature for muscular fibres always preserving the same density may be, that as some of them are intended to act in circumscribed cavities, no inconvenience should arise from their occupying more space at one time than another. What produces the hardness of the muscular fibres when in action, is still unknown.

Muscular fibres cannot, in ordinary cases, continue for any great length of time in active contraction ; after a certain time, their contraction must be succeeded by the state of relaxation.

If we attend to a voluntary muscle made to contract, and required by the will of the mind to remain forcibly contracted for some time, for example, the deltoid, when a weight is held at arms length, we shall find, that although the muscle generally remains contracted, many of the packets of fibres composing it, are contracting and relaxing alternately, apparently with the view of relieving each other; the muscle is at first steady ;

but as it tires, a little quivering is felt, and when the strength of the muscle is nearly exhausted, the alternate contractions and relaxations of its fibres become very discernible.

In cases however, where the fibres are under some diseased influence, as in violent spasms, tetanus, &c. the contraction will remain for a long time without any attempt at relaxation.

We find it difficult to keep any part of our bodies long in one posture; the reason is, that some muscular fibres are in action to preserve that posture, and therefore, after a time, numbness and fatigue are the consequence. In proportion, as more muscles are used to produce or continue any posture, the fatigue is greater.

The state in which muscular fibres generally remain for the longest period, is that of relaxation; but still, when they have remained long in this state, a sense of weariness is produced, nearly similar to that which follows long continued exertion, It is from this, perhaps, that in sleep, we change our position.

Relaxation is the state in which muscular fibres recover from fatigue, after having been for some time excited to contraction: in this state, the fibres are more or less elongated, and have also a softer feel.

In a living body, relaxed muscular fibres have not that soft flabbiness, which they are observed to possess in dead muscles; but they maintain a certain degree of firmness to the touch; and a proportionable length to the situation of their extremities.

All muscular fibres in their healthy state, have a constant disposition to contract, and therefore, they are constantly and independantly of any known stimuli, in a greater or less degree of tension: this is proved by the divided parts of a living muscle retracting immediately from each other, as is seen in operations, crimping of fish, &c. it is further proved by what takes place in the wry neck, and in hemiplegia.

This constant disposition to contraction, is called the tone of the muscular fibres.

In order to maintain this tone, equally and generally over the body, every muscle has some counteracting power, such as connection to fixed parts, some opponent muscle, the quantity of solids or fluids contained in cavities, or vessels, whose coats are muscular; it is from this, that we always find the stomach, intestines, bladder, &c. as well as the blood vessels, so contracted as to be adapted to their contents.

The relaxation of muscular fibres, does not depend upon any innate power, as the contraction does; but is produced by external causes, acting immediately on them; for instance, to relax the flexor muscles of a part, the extensors must be called upon to act.

Unless muscular fibres are called upon to act, whether we are asleep or awake, there is no more contraction in them, than what arises from their tone; i. e. they adapt themselves to the present distance between their extremities, but without becoming hard or forcibly contracted; if we lay our leg upon a stool, the muscles which would have sustained our limb in that posture, had there been no stool, although they will be found to have adapted themselves to the length between, their extremities, are soft, and apparently inactive; take away the stool without moving the leg, they immediately become hard, and are in strong action.

In sleep, there is no more action, than what arises from tone.

There are some muscles in the body, which are usually found in a state of contraction, viz. those which are placed at the extremities of some of the canals, and which are called sphincters. The fibres of these muscles are in nothing different from the fibres of others, excepting in their having no opposing power to that disposition to contraction or tone, which all other muscular fibres possess.

It is to be observed, that the fibres of sphincter muscles are found only in a middle state of contraction, and by no means in the greatest degree of which they are capable.

They are also under the influence of volition, and can be made to contract more strongly, when from the usual natural stimulus, they would have become relaxed.

We do not thoroughly know the exact quantity of contraction, which muscular fibres are capable of, but we are certain, that this quantity is very considerable.

In the bladder, instances of the lengthening and contracting of muscular fibres, are strongly marked in the over distended, and the contracted state. In the one state, the bladder may contain some pints of fluid, in the other, a single drop will fill its cavity.

It appears however, that when the muscular fibres of the bladder have been distended to a very great degree, and kept long in that state, they will lose for a time, their disposition to contraction, and when the urine has been drawn off by the catheter, they shall not then contract, but the bladder shall remain in a passive and flabby state; it is this which often produces the necessity of introducing the catheter repeatedly, after the first obstruction has been removed, to give time for the bladder to recover its tone.

The muscular fibres which enter into the composition of arteries and veins, have, in cases of great loss of blood, and in animals bled slowly to death, contracted those vessels, so as very nearly to have obliterated their cavities.

The quantity of contraction, which muscular fibres are capable of, may be very much improved by the muscles to which they belong, having been early and frequently called upon to act; as in tumblers, posture-masters, &c. who by early and constant practice, can bend themselves backwards, so as to bring their heads between their legs.

The power of repeating the contraction, and relaxation of muscular fibres, within a given time, is astonishingly great; we have instances of this, in the velocity with which the fingers of an able performer on the piano forte will move over the keys; in the rapidity with which the contractions and relaxations of the muscles of a race-horse in full speed, will succeed each other. The instances are, perhaps, more remarkable in the wings of birds, and in the human subject being capable of pronouncing, what it would take fifteen hundred letters to express, in a minute. The quantity of contraction, and the repetition of it in a given time, are thus much improved by habit.

The strength of muscles, in a state of contraction, depends partly upon the number of fibres which enter into their composition, and partly upon the degree of contraction into which they are thrown.

The number of fleshy fibres in two muscles being the same, and the muscles having similar attachments, the superior strength exerted by either muscle, will depend entirely upon its degree of contraction; this degree of contraction may be increased by habit; and so far, habituating muscular fibres to action, will tend to increase their strength.

Habituating a muscle to action, increases also its strength, by increasing the number of its fibres; this is proved by the muscles particularly used in hard-working people, increasing in size. This we find in the arms of watermen, sailors, blacksmiths, gold-beaters, &c. and in the legs of those accustomed to walking, and carrying weights. Milo, at the Olympic games, is said to have carried an ox a furlong, having began and continued to carry the animal daily, from the time it was a calf. One reason for supposing that the muscles of some of the Grecian statues are not out of nature, in the largeness of their swellings, is, that they generally were copied from gladiators, or men whose strength was cultivated from their infancy, to enable them to contend with advantage at the different games.

The strength which can be exerted by a living muscle, must be considerably greater than the cohesive strength of the same muscle, when dead; thus, a weight appended to a dead muscle, will tear it, although much less than the muscle could lift with ease when alive.

The contractile fibres of dead muscles are torn through, with a much less weight than the tendinous fibres belonging to them; but in a living body, it is the tendon which gives way. The tendo Achillis is sometimes torn through, by the force exerted by the fleshy fibres of the gastrocnemius and soleus muscles. Even the patella is occasionally fractured, by the sudden and conjoint contraction of the flexor and extensor muscles of the thigh; as in falling, when the mind in confusion issues its orders for both sets of muscles to contract at the same instant.

Muscles will generally be found to possess more absolute than relative strength.

By absolute strength is meant, that power which a muscle exerts, to lift the greatest weight it is capable of, having the most advantageous situation and insertion for so doing.

By relative strength is meant, that force which a muscle is capable of exerting as attached to the skeleton; or, in other words, muscles are not situated so, as to be capable of exerting the whole of the strength which they possess from muscular fibres upon bones. Indeed, a great waste of mechanical power is often incurred, by the manner in which muscles are inserted into bones. This takes place from two causes.

1st. They are applied at acute angles to the bone. 2dly. They are usually attached very near to joints; and from both of these circumstances, their powers must be very considerably lessened.

From muscles being inserted obliquely, and lying nearly parallel, and close to the bone upon which they are intended to act, a great part of their force must be expended in pressing one bone against another at the joint; and but a small portion of it used in making the flexion or extension. Had their insertion been at right angles, it is obvious how much greater their power in moving the bone would have been.

From being attached near to a joint, the waste of mechanical power must also be very great, owing to their having a great length of lever to raise. Thus, the biceps flexor cubiti and brachialis internus, in order to support in the hand, a weight of one pound, must exert a force at least equal to ten pounds.

Some physiologists have calculated, from taking these and some other circumstances into consideration, that provided the deltoid muscle was unassisted by others, to raise a pound weight hung at the fingers, and support it with the arm extended, it must exercise a power equal to 1170 pounds.

The principle of the steel-yard explains how this may happen.

These disadvantages are so considerable, that we must naturally expect some great convenience to arise from the situation of muscles, so as to compensate for the loss of power; and accordingly, we do find essential advantages to arise, both in the shape of the limb, and in the velocity of motion.

Unless the muscles and tendons ran very nearly in the direction of the bones, they must have passed like bow-strings from one bone to another, in making the flexures of the joints. Suppose the biceps flexor cubiti had been inserted into the middle of the radius; if the fore arm was bent, there would have been a considerable swelling of the muscle at the joint: this would have proved very inconvenient. By being placed as it is, the limb is rendered more graceful and commodious in form; at the same time, a small contraction of the muscle produces a very considerable flexion in the fore arm, and this with much greater velocity than if it had been inserted lower down.

Muscular fibres generally run in an oblique direction to the course of the muscle which they form; this is often more observable in the internal part of the muscle than on the surface. Had the whole of the fibres ran in a straight direction to the muscle, it would have had the power of contracting more of its length; but nature, in forming this oblique arrangement of fibres, had a view more to the strength than to the extent of contraction; for, in consequence of this obliquity, muscles possess more fibres than they could have had with the same bulk, had the fibres run rectilineally; and the increased strength from the fibres being multiplied, more than compensates for the want of power arising from oblique action. The penniform and half-penniform muscles shew the advantages of this arrangement of fibres.

It has been geometrically demonstrated by Dr. Monro, and Sir Gilbert Blane, that in oblique muscles, the same effect is produced with a less proportional decurtation of fibres, than if the same motion had been performed by a direct power. So that in oblique action, upon the whole, there is greater strength; and there is also a saving of contraction; consequently, of fatigue.

There is another advantage in having penniform muscles, viz. when such muscles are contracted, they do not form large and thick masses of flesh, but regular and gentle swellings along the bones.

There are very few muscles in the body which are intended to produce but one simple action.

Muscles produce different actions, according as the parts to which they are attached are moveable, and according as they are assisted by other muscles. It is the combination, indeed, of action in different muscles, that causes the great variety of motion of which our bodies are capable; and it is this co-operation, which produces the effect of making all our movements flowing and easy.

There is no such thing as moving a single muscle independently of others, as, for instance, if we wish to move the two extreme joints of the fore-finger a very little, the action is performed by the flexor muscles; but the extensor muscle, on the back of the finger, is also in action, to prevent the finger from bending too far. In the apparently simple motion of bowing, it is supposed that all the muscles, from the head to the foot, are put into some action.

The motion of muscles has been divided into the voluntary, involuntary, and mixed.

The voluntary, are those original motions, which are produced or stopped at pleasure, by the will of the mind, and of the performance of which, we are always conscious; as in intentionally moving any particular part.

The involuntary, are those which are constantly going on, apparently without our knowing of them, as in most of those actions on which life immediately depends, viz. the action of the heart and blood-vessels, stomach, intestines, &c.

The mixed, are those motions, which, though they may be stopped for a time, rendered more slow, or accelerated by the will of the mind, yet, in general, go on without being at all directed by it; as in respiration, the motion of the eye-lids, &c.

The causes of muscular motion are various.— The first, is volition of the mind.

Those muscular fibres, on the constant action of which, life depends, are not under the influence of this cause. In order to produce action in muscles from volition, it is necessary that they should be connected to the brain, or spinal marrow, by nerves.

The volition of the mind is not directed to the muscles themselves; but to the effect intended to be produced by their action. Thus, when we mean to walk, the mind is not conscious of giving its orders to any particular set of muscles; it is only conscious of the effect intended to be produced; and willing it, the proper muscles are immediately called into action, and this with inconceivable celerity.

When muscles have for sometime been habituated to a certain action, they can go on with this action, without the attention of the mind being kept constantly directed to it, as in walking, and thinking on some particular subject; or solving some difficult question; or playing accurately on an instrument, and conversing at the same time.

All those muscles which are under the influence of volition, are subservient to common actions, and not to functions essential to life: those which are essential to life are very wisely placed beyond the reach of the will. The human mind, under many circumstances, may be abstracted from the feelings of the body and surrounding objects, so that the actions essential to life, had they been dependant on the will, would not go on at all; or in other instances would be liable to be stopped by caprice or any sudden disgust. It has therefore been ordained by nature, that these actions should not be under the influence of volition, for had they been so, we could not have attended to them and to the voluntary ones at the same time, and the first neglect of them would have been followed by the loss of life.

We know not what produces or continues the involuntary actions, nor have we any consciousness of how or when they began; but we find that they differ from all other actions in this, that the muscles performing them do not tire; but continue through life acting as if they were incapable of fatigue.

The action of some muscles is involuntary in regard to the regular and constant action, and voluntary in regard to the occasional. The muscles of respiration are of this kind. Respiration is essential to life; so far it is necessary that the muscles producing it should be involuntary, they are constantly acting, and respiration seems to be going on as uniformly without the attention of the mind as the circulation of the blood; it goes on perhaps more regularly in sleep; and often in cases where from injury done to the brain, both sensation and volition have been suspended, it has been very little altered. So far it is involuntary.

Respiration however can be regulated and varied infinitely by volition. We can breathe quick or slow, take full or small inspirations, throw out the air gently or violently according to our will; and could a person, wishing to die, exert sufficient resolution, respiration might be stopped entirely through the influence of the will.

It is necessary that this action should be, to a limited extent, under the power of the will, when the body is under certain influence, as in coughing, or straining, also when breathing a putrid, or otherways tainted atmosphere. It is here worthy of remark, that in the common moderate action of respiration, the muscles employed in it, like the involuntary muscles, never become fatigued; but a sensation of fatigue is soon produced, if their action is much increased by the will, or by any accidental circumstances.

The power of the will over voluntary muscles may be increased, by it being particularly directed to any one set; of this we have proofs in musicians, and mechanics, who being accustomed to a certain action, will perform it with velocity and accuracy, which can only have been attained by long practice.

By frequent attempts the will may also acquire a power over muscles upon which it had not much influence before. A person after he has engaged in the study of anatomy, has acquired the power of bringing into action any single muscle of the face.

The mind has occasionally re-acquired a power, which it had lost, over muscles which had become fully contracted, in consequence of the rupture of a tendon, or fracture of a bone, as in the rupture of the tendo achillis, fracture of the patella, &c. and in instances of new formed joints in cases of unreduced dislocations, more particularly of the os brachii, and os femoris, it has educated muscles to act on such joints.

The power which the mind or will has over other muscles, may be much diminished, or at last totally lost, from not being exerted, as the use of the muscles of the external ear.

We find that volition may be communicated along the trunk of a nerve, then through some branches, and not through others; but how this happens we do not know.

Ideas, and passions of the mind, are the second cause of muscular action. These may and do produce effects on muscular fibres, which are distinct from those excited by the will, and which indeed sometimes take place in direct opposition to it. Although the action of the heart and arteries cannot be affected by the will; emotions of the mind produce very strong and visible effects on such actions: we all have witnessed this in the effects of fear, grief and joy.

A striking instance of the effects of the passions upon the muscular action, is the influence which some of them have on the strength of muscles, as courage or enthusiasm. Madness is also referrible to passions of the mind, and the almost incredible feats of strength performed by maniacs are farther illustrations of this.

It is well worthy of remark, that in these instances of uncommon exertion produced by active passions of the mind, debility and fatigue do not take place in the same proportion by many degrees, as they would do had the same quantity of action been exerted without their influence.

Stimuli, applied either to the nerve leading to the muscle, or to its substance, are the third cause of muscular motion. Stimuli may consist of those which are formed in the body itself, and which are at all times necessary to parts going on with any particular action; and of those which are occasional, or made by impressions of outward bodies.

The power of a stimulus must be according to the nature of the part to which it is applied, and its disposition to be stimulated. Thus the bile, mixing with the food in the small intestines, will stimulate them to go on with their functions; but although equally fluid with the chyle, it will not stimulate the absorbents to receive it into their cavities. Light stimulates the retina, and this disposes the iris to elongate its radiated, and contract its circular fibres, so as to lessen the circumference of the pupil of the eye. Urine stimulates the bladder, not by its acrimony, but by distention ; but all other parts, excepting its natural containing vessels, it would stimulate by its acrimony.

These instances are sufficient to prove, that muscular fibres in different parts of the body are peculiarly constituted, either to be acted on, or to resist the action of the different substances, with which they naturally are to come in contact; of course, that a particular stimulus may produce violent effects in one part, when it will have little or no effect when applied to another.

This disposition in several parts of the body to perform their natural functions, in consequence of the application of their peculiar stimuli, has been called the natural perception of the part.

When any mechanical or chemical stimulus is applied to a nerve, the muscles supplied by its branches are excited to contraction ; but no change is observable in the nerve in consequence of the stimulus. In this case, the excitement is carried along the whole of the branches belonging to the nerve, so that all the muscles supplied by it are roused into action; it is not partially conveyed, as is the case in volition.

A stimulus applied immediately to muscular fibres, will also excite the muscle to contraction. Such stimuli may be of various kinds, as puncturing, cutting, lacerating, applying concentrated acids, or burning.

It is also found, that although all connection between the brain or spinal marrow and the muscles be destroyed, and although this prevents the mind from having any power over the muscles, it does not destroy their irritability, or power of contracting from external stimuli: for when a muscle has been completely removed from every connection with the brain, even when it has been cut out of the body, it may, by the application of a stimulus, be excited to act or contract for some time.

Muscles, in different classes of animals, retain the power of being excited, some for a longer, and some for a shorter time, after all communication with the brain and spinal marrow has been cut off. In man, and in quadrupeds in general, this power remains for a very short time; but the muscles of a turtle, viper, or skate, will contract several hours after their division from the body; the heart contracts for a longer time than any other muscle, even for twenty-three or twenty-four hours. Indeed the contraction of muscles is much less immediately dependant on nerves in amphibia and fish, than in common quadrupeds; for although the heart of a quadruped will contract for some time after it has been removed from the body, when a stimulus is applied to it; yet that time bears no proportion to that in which muscles will contract in the other classes.

Some animals are so simple in structure, that neither brain or nerves have been detected in them, yet these animals have loco motion.

It has been doubted, whether or not the contraction of muscular fibres, when stimuli are applied to the body of the muscle, and not to the trunk of the nerve belonging to it, takes place in consequence of a small branch of the nerve distributed through its substance being affected by them; or in other words, whether the irritability, or susceptibility of receiving impressions from external stimuli, does not reside in the smaller ramifications of the nerves distributed through the muscle.

The following facts, afford some ground for inference, that the irritability is in a great degree distinct from, and independent of the nerves.

A muscle will be excited to contraction upon the application of stimuli, several weeks after all communication between it and the brain has been destroyed, and when the nerves remaining in its substance may reasonably be supposed to have lost all that influence, whatever it is, which they had derived from the brain; and more particularly so, as not the smallest motion is perceptible in the nerves belonging to those muscles, to which very irritating stimuli have been applied, whether these have been applied to the trunk of the nerve, or to the substance of the muscle. And that several animals are endowed with the power of muscular motion, in which neither brain or nerves have been discovered, as the leech, polypus, &c.

A great variety of theories have been formed, as to the nature of muscular motion, both on the cause producing it, and the structure of the fibres; but the objects being too small to be accurately examined by our senses, and the connection between soul and body being so little understood, render all that has been said, and probably all that will be said, on this subject, mere hypothesis and conjecture. I shall not trouble you by reciting any of these theories; some of them are very absurd, and a few of them very ingenious. It is easy to start objections to any hypotheses that have been raised; but from the data we at present possess, nothing certain can be established.

We know that muscular fibres in action, become harder, and generally shorter; we know that they may be excited to action, by different stimuli, applied either to their nerves, or to their substance;

but we know nothing of the actual change that takes place in their minute structure. We must, therefore, at last refer muscular motion to an original principal of animated matter, by which, certain fibres are capable of contraction and relaxation: but for which, no cause has as yet been assigned, any more than for gravitation, cohesion, or chemical affinity

LECTURE IV.

ON THE ANATOMY AND PHYSIOLOGY OF THE HEART.

In Lectures given professedly upon the vascular system of the human body, the heart cannot be passed over slightly: as it not only is the centre of that system; but is also the immediate organ which circulates the blood over the body, to accomplish the great ends for which that important fluid was formed.

The precise relative situation of the heart cannot easily be explained by oral description, unaided by demonstration. One clear demonstration on the dead body, where every part referred to can be seen, will afford more real and permanent information, than all the elaborate descriptions that ever have been spoken or written. These demonstrations have been given, or attended to, by every one now present.

The human heart is a muscular body, of an irregular conical shape, containing four great cavities, which are so placed, between the terminations of the veins and the beginning of the arteries, that no blood can pass from vein to artery, without passing through two of these cavities: nor can blood circulate twice over the body, without having passed through the whole of the four.

The auricles, or cavities, which receive blood from the veins, are situated at the base of the heart. The ventricles, with which the auricles communicate, and into which they transmit the blood, form the body and apex of that organ.

The auricles have thinner coats, and are much more irregular in shape than the ventricles.

In the situation, shape, and formation of the heart, there is much variety in different classes of animals; and although it is an organ of much importance in most animals, it is not an organ essential to life in all; for animals exist, in which no heart has been discovered, viz. the race of polypi, and those which have but one continued intestine.

In the larva of the silk worm, instead of a heart, there is a single vessel on the back.

In the leech there is one serpentine vessel on the back, and two vessels on the sides of the belly, which are supposed to be veins, these vessels communicate by lateral branches.

In the earth worm there are two vessels, one on the belly, and the other on the back, and five cross vessels on each side, which pass from the one of these to the other, communicating with and connecting them together. The use of these cross vessels has been supposed to be something like that of the heart, viz. contracting on, and keeping the blood in constant motion.

The medusa possesses a cavity nearly in the centre of its body, which seems to answer the double purpose of heart and stomach; for the food of the animal enters this bag, and many vessels, similar to arteries, which anastomose beautifully with each other, run from it into the tentacula and other parts of the animal.

Some animals which are supplied with nerves, exist without having hearts; and some even possess organs of generation which have not this viscus.

The heart is simple or single in some animals, in others it is compound or double.

A single heart consists of two cavities, viz. an auricle, and a ventricle. Indeed in many insects, the heart is still more simple, consisting only of one cavity, viz. a ventricle, which is filled with blood from the veins, and when distended, contracts and propels it into the arteries.

In most fish, there is a single heart, consisting of one auricle and one ventricle.

Single hearts, in some animals, as in most fish, receive the blood from the veins of the body, and convey it to the organs of respiration; the aorta or artery, which conveys it over the body, arising from the union of vessels coming from the gills.

In other animals, as in the flying insects, the heart receives the blood from the veins of the body, and propels it into the arteries, these convey it to every part of the animal. The organs of respiration are so disposed in such insects, that the blood is purified by circulating over their bodies, without being carried to any particular structure, such as lungs, or gills, formed in the more perfect classes of animals for that purpose.

In the frog, the blood is received, both from the body, and from the lungs, into one auricle, and sent thus mixed into one ventricle, from whence it passes into a single arterial trunk, which divides into the aorta, and pulmonary artery.

I have met with this structure in a child, who lived some days, and have described the arrangement of vessels, in a paper published several years ago in the Philosophical Transactions.

In some shell fish, the heart is found to possess two auricles and one ventricle, as in the oyster, and fresh-water muscle.

In some amphibious animals, there are two auricles, and an approach to two ventricles, the septum between them being perforated, as in the turtle. Preparations shewing the different structures, which I have here briefly noticed, are preserved in the museum of our college.

In the human fœtus, and in those of quadrupeds, the heart may be considered as consisting of one auricle and two ventricles, the foramen ovale forming a free communication between the auricles; but closing after birth. Both ventricles before birth, are equally strong, and both in consequence of the ductus arteriosus uniting the arteries arising from them, are employed in propelling the blood into the descending aorta and its branches, of course, along the funis to the placenta.

The immediate use of the heart, is therefore different, in different animals; for in some, the heart sends the blood to the lungs only, in others, to the body only, and in others, to both; but it is in all animals, the organ employed to throw the blood into those parts, into which the arteries conduct it.

The human adult heart, is a double, or compound one; so are the hearts of most quadrupeds and birds. Among fish, the whale has a heart of this kind.

A compound heart is made up of two simple systems laid together; one auricle receiving the blood from the veins of the body generally, and transmitting it to the ventricle, and this last, propelling it by the pulmonary artery and veins, through the lungs; the other auricle receiving the blood from the veins of the lungs, transmitting it to the corresponding ventricle, which propels it to the aorta; and by the ramifications of that vessel, it passes to every part of the body.

The single hearts belonging to each of these systems, might have been placed in the same body far from each other, and the circulation might have been carried on uninterruptedly; but it appears to have been more convenient, that all the blood vessels should have one common centre; accordingly, we find the two auricles and two ventricles placed together, but divided from each other by a partition called the septum cordis.

The human heart is situated in the middle of the cavity of the thorax, between the sternum and the spine, and immediately above the tendinous centre of the diaphragm. The lungs are placed on each side of it, and when fully inflated, they extend a little both before and behind it.

The heart is confined to this situation by the pericardium, which first forms a loose bag to connect and contain it, and afterward is reflected immediately over its substance, so as to give to it an external smooth surface, thus covering the heart, as the head is covered in persons who wear a double night-cap.

The pericardium forms a bag without any entrance leading into its cavity; when an opening is made into the bag, the heart appears to project into the cavity, and to receive a covering from the membrane forming it.

The pericardium is thick and strong where it forms the containing bag: and is thin and smooth where it forms the immediate covering to the heart.

The size of the bag which the pericardium forms, is larger than would be required, merely to contain the heart; for it is large enough to contain that viscus when its four cavities are distended, which they never can be at the same instant during life; for when the auricles are filled, the ventricles are empty, and vice versâ.

The pericardium is fixed below, to the upper surface of the centrum tendinosum of the diaphragm, to which it so firmly adheres, that without the destruction of fibres, the one cannot be separated from the other. On its anterior part it is connected obliquely to the inner surface of the sternum by means of the two pleuræ which form the anterior mediastinum; behind, it is connected by the pleuræ forming the posterior mediastinum to the sides of the spine; above, and wherever there are vessels passing into, or coming out of the heart, the pericardium is reflected over these vessels until it reaches the heart, over the external surface of which, I have already stated, it is continued.

The pericardium receives its arteries from the trunks in its vicinity; chiefly from the aorta, mammariæ internæ, and phrenicæ. The veins of this membrane correspond much to its arteries; they follow at first nearly the same course, afterwards, some join the veins of the thymus gland, and pass into the subclavian veins; others run backwards, and enter the vena azygos; others join the veins of the diaphragm.

Most of the absorbent vessels join the trunks of those coming from the heart, and having previously passed into the same glands, enter either the thoracic duct, or the right trunk of the absorbents.

Small filaments from the parvagum and intercostal nerves, can be traced into the pericardium; so may minute ramifications from the phrenic trunks.

The pericardium, where it forms the containing bag, consists of two laminæ; the external of which puts on a glistening tendinous appearance, and exhibits packets of fibres running in various directions; where it is reflected over the heart, the capability of its being divided into two laminæ ceases, and the fibrous appearance is lost. The internal lamina is thin, but dense: its inner surface is smooth, and moist; it is lubricated by a fluid, termed the Liquor Pericardii.

This fluid differs in no material property from the serum of the blood: it has, perhaps, more water and less coagulable matter, and during health it is secreted in no larger quantity than is merely sufficient to keep moist the inner surface of the membrane. In disease, the liquor is, from the density of the membrane, sometimes accumulated in a large quantity forming the hydrops pericardii. Fluid sometimes accumulates in the cavity of the pericardium after death, from the thinner parts of the blood transuding through the coats of the heart, and being retained in this membrane, by the density of its structure; but when accumulated from this cause, it generally has a bloody tinge. As no glands are found in the pericardium, the liquor pericardii must be separated from the blood by exhalant arteries.

The heart is thus in possession of a determined cavity, in which its motions may go on uniformly and uninterruptedly, whatever may be the position of the body, or the state of the other viscera, as to fulness or emptiness. The necessity of a pericardium for this purpose, appears so absolute, that we find it in all animals which possess a heart. In those animals which have no diaphragm, the pericardium is firmer and stronger than in those which possess one to which it can be intimately attached.

One use ascribed to the pericardium has been to limit the growth of the heart; but if so, what is there to limit its own growth? This supposed use is negatived by the known fact, that when, from any cause, the heart increases in bulk, the growth of the pericardium always keeps pace with it.

Deviations from ordinary structure have often assisted in explaining circumstances in the animal œconomy which before were obscure; and although cases have been related of the want of a pericardium, and symptoms described supposed to be owing to that deficiency, many anatomists and physiologists, even Haller, have considered that a lusus of this kind had never taken place; and have asserted that the obliteration of the cavity of the pericardium, an effect of the adhesive inflammation, had been mistaken for the original want of it. Doctor Baillie, however, in a body used for the demonstration of the viscera in his lectures in Windmill Street, found an original deficiency of pericardium, and an account of it has been published in the 1st vol. of Transactions of a Society for the Improvement of Médical and Surgical Knowledge. The heart in this body was much elongated towards the left side, was covered by the pleuræ, and connected by these membranes to the diaphragm, sternum and spine. This case, as the man was at least forty years of age, proves that the pericardium is not absolutely necessary to life. Whether this man, when alive, could bear violent exercise without fainting or palpitations of the heart, could not be ascertained; but as he died in an hospital of chronic rheumatism, the Physician who attended him was applied to for information, and he did not recollect that any thing remarkable had been perceived either in his pulse, or other symptoms.

Although the general appearance of the human heart is convex and conical, the under surface of it is flat and corresponding to the flat upper surface of the centrum tendinosum of the diaphragm on which it rests; but in quadrupeds, where it cannot have such support from the horizontal position of their bodies, the heart is convex all round.

The situation of the heart is diagonal or oblique in respect to the body, *i. e.* its base is turned backwards and towards the right side, and its apex forwards and towards the left: its base however does not project so far to the right side as its apex does to the left.

In consequence of this obliquity, one ventricle, and one auricle are placed so much before the others, that the term anterior auricle, and anterior ventricle, would be as applicable to them as that of right, by which last term they have usually been distinguished; and for a similar reason the term posterior would be equally applicable to the auricle and ventricle usually called the left.

The ventricles form the body and apex of the heart; they project into the pericardium, and are tolerably uniform on their surface. The auricles are situated at the basis, and from the number of vessels entering them, as well as from other causes, they are much more irregular in their appearance.

The veins pass into their auricles as far from the apex as possible; but the arteries arising from the ventricles are not so far from that part of the heart. Although the heart does not project so much to the right side as it does to the left, from the shape of the cavities, and thinness of the coats of the auricles, were a longitudinal section to be made through the thorax from the middle line of the sternum to that of the spine, as much real extent of space in the cavities of the heart would be found on the one side as on the other.

In examining the interior structure of the heart, we may with advantage follow the course of the circulation of the blood.

The blood which is returned from the body enters the right auricle. The partition between the two auricles is called the septum auriculorum, and is placed towards the left and posterior part of the right auricle.

In shape the right auricle is oblong, its greatest length being from above downwards. The upper and anterior edge of it has an appendix projecting some way before and partly concealing the origin of the aorta, it resembles a little the flap of a dog's ear, and from this supposed resemblance the whole cavity derives its name. The ancient anatomists indeed confined the term auricle to this part, the rest of the cavity they called the sinus of the superior vena cava, applying the term superior not only to the vein now so designated, but also to that part of the vena cava inferior, which is placed above the liver: this may be seen in the plates of Eustachius.

The vena cava inferior, returning the blood from all parts below the diaphragm, enters at the under and back part of the right auricle; and the vena cava superior returning the blood from all parts of the body above the diaphragm, enters at the upper and back part; so that the bulk of the auricle is placed before and a little to the left of the entrance of these veins.

Although one of these veins ascends, and the other descends, they do not enter the auricle in immediate opposition; but form a very obtuse angle, by each inclining a little forwards and to the left side: the entering streams of blood are thus directed in the diagonal towards an opening, communicating with the right ventricle, termed ostium venosum.

The pericardium gives a smooth appearance to the outside of the auricle; but from its thinness and transparency, we can perceive in many parts that it covers muscular fibres arranged in packets, with spaces between them, through which spaces the colour of the blood in the auricle may be seen; in other parts, where the muscular coat is thicker, and the fibres more regularly disposed, the colour of the blood cannot be seen.

When the auricle is laid open, its coats, between the entrance of the two great veins, are found to form a slight eminence projecting towards the opening leading into the ventricle. The name of tuberculum Loweri has been given to this projection.

The fasciculated structure of the muscular fibres, renders the inner surface of the anterior part of the cavity very uneven, as it forms many oblong ridges, having cavities between them, with lesser ridges and cavities passing off obliquely from the larger. This arrangement of fibres has been called the musculi pectinati cordis; it is much more marked and prominent in the appendage, than in any other part.

Why the muscular fibres should be thus collected and arranged is not an easy matter to explain. It has been asserted, that it was to prevent the blood which passes into certain parts of the heart, not in the direct passage from the auricle to the ventricle, from stagnating, no musculi pectinati being found in other parts; but this does not satisfactorily account for their formation; as we do not know why parts of the heart should be formed, in which the blood would be likely to stagnate. It has been stated that the musculi pectinati have the use, by agitating the fluid in the right auricle, of mixing the blood and chyle more intimately and quickly: they may have this use, but it is by no means certain that they were formed for this express purpose.

The internal membrane of the auricle is smooth, thin, and dense, and is evidently continued from the internal membrane of the veins; it lines the muscular coat, and between some of the musculi pectinati it comes in contact with the pericardial covering.

The septum auriculorum is placed in an oblique direction, its surface in the right auricle looking forward and to the right side; it extends from the posterior part of the auricle to the opening communicating with the ventricle; it is thus placed before and partly on the right side of the aorta.

If the auricle is opened carefully on the middle of the anterior part, by an incision from the superior to the inferior vena cava, the tuberculum Loweri will be seen to form a projection between the two veins, and by increasing the angle between them it will, during life, assist in directing the two streams of blood towards the ostium venosum. This tubercle is formed partly by condensed cellular membrane on the outside, and partly by an increased thickness of muscular fibres towards the cavity of the auricle; it forms a projecting ridge crossing the septum; it inclines downwards before it reaches the ostium venosum and is continued into the extremity or cornu of a considerable valve, which valve increasing in breadth takes a direction between the ostium venosum and the inner and anterior part of the vena cava inferior, to which its lower edge or largest circumference is firmly attached; the valve is then continued round the entrance of the vein until its other cornu reaches and is continued into the tuberculum Loweri. This is the Eustachian valve, or valvula nobilis; and taken with the tuberculum in the distended state of the auricle, it forms an opening nearly of a circular figure, through which the blood from the vena cava inferior enters the auricle; this opening is therefore bounded above and behind by Lower's tubercle, and below and before by the Eustachian valve; it is shaped like an oblique section of the end of a cylindrical tube, and fronts the ostium venosum. This description, it is hoped, will convey a sufficiently distinct idea of the true situation of the valve, as it has been rather inaccurately represented in the works of anatomical authors, and some uncertainty in consequence has prevailed concerning it.

The part of the septum auriculorum below the tuberculum Loweri, will in reality be found to belong more to the vena cava inferior, than to the heart; the tubercle and the Eustachian valve united, forming the proper opening of the vein. Boerhaave, Haller, and some others, distinguish the part of the auricle, near the septum, by the name of sinus, and call the anterior part only auricle.

In the space alluded to, immediately below the tubercle, there is a depression of an oval shape, the edges of which are more prominent above nearest to the tubercle, than below or nearest to what is usually called the entrance of the vein. The projecting circumference of this depression is called the annulus fossæ ovalis, and the depressed part is called the fossa ovalis. The depressed part consists of a thin membrane, attached firmly to the annulus, excepting at the upper part, it there passes beyond and behind the tubercle and ridge, so that a probe may be introduced to some depth between them; it will be found either to terminate in a cul de sac, which is more usually the case, or will continue to pass obliquely through until it reaches the cavity of the left auricle. In those cases in adults, when the probe will pass in the dead body, in the living, from the oblique direction of the passage, no blood could pass from auricle to auricle; as the pressure arising from both auricles being filled at the same time, would, in the right auricle, propel the annulus against the membrane, and in the left auricle, would propel the membrane against the annulus.

In the fœtal state, the membrane of the fossa ovalis is for a considerable extent unattached above, so that it forms a regular valve, leaving a large opening between it and the annulus so placed, that as the right auricle, before birth, has all the blood returning from the body of the child and placenta carried into it, excepting the very small portion which enters the left auricle by the pulmonary veins, and which auricle is therefore comparatively empty, and cannot propel the valve towards the annulus, the large current of blood from the vena cava inferior, must press the membrane from the annulus, and a sufficient quantity will rush through the opening into the left auricle, so as to distend it. This opening is called the foramen ovale; the rest of the blood passes into the right auricle, through the oblique opening formed by the junction of the extremities of the tuberculum Loweri with the Eustachian valve, and thus, both auricles become distended at the same instant.

After birth, the pulmonary veins transmit the proper quantity of blood to fill the left auricle, the valvular aperture of the foramen ovale then gradually contracts and closes so as to admit no passage to the blood through it.

About the tuberculum, Eustachian valve, and annulus ovalis, there is a particular arrangement of muscular fibres, which has not, I believe, hitherto been described; but which can be very distinctly traced in the heart of a calf.

The membranous part of the fossa ovalis is, in the fœtus, sometimes so perforated, as to resemble a rich lace work. I have met with this reticulated appearance in the Eustachian valve, often in the fœtus, and occasionally in the adult.

Between the Eustachian valve, towards its left and posterior extremity and the ostium venosum, the entrance of the large coronary vein is placed—

a vessel which returns the blood from the substance of the heart. There is a small single valve placed at the entrance of this vein, one extremity of which joins the Eustachian valve, and the other the ostium venosum. This coronary valve is often imperfect, and frequently is perforated like a rich veil. It is nearly at right angles to the Eustachian valve, and its supposed use, along with that valve, is to prevent the force of the larger current of blood from the two venæ cavæ, impeding the entrance of the smaller and less forcible current by the coronary vein.

A number of small openings are to be perceived in other parts of the auricle; they are of different sizes, but into many of them a large bristle may be passed. They have been termed foramina Thebesii. Formerly, they were supposed to be the excretory ducts of glands; but are now ascertained to be merely the entrances of some of the lesser veins from the substance of the heart.

On the left and anterior part of the right auricle is the passage of communication with the right ventricle, called ostium venosum. This opening is of an elliptical shape, and its margin is smoother and of a whiter colour than any other part of the auricle. Lower thought that a tendinous ring was formed here, which he called the tendo cordis venosus.

The auricle having become distended, by the blood poured into it by the two great veins, contracts through the whole arrangement of its muscular fibres, and forces the blood through this opening into the right ventricle.

There is no valvular apparatus at the entrance of either of the two venæ cavæ to prevent the blood returning into them when the auricle contracts, nor is such apparatus necessary, on account of the constant momentum with which blood continues to arrive at, and to be passed into the auricles from the veins, and also from the blood finding no resistance in passing through the large opening into the ventricle. In animals which have been sacrificed for the purpose of observing this, the auricle has been seen to begin its contraction at the parts where the veins enter; and in cats and rabbits, the contraction has been observed to begin even in the veins themselves. The Eustachian and coronary valves are also so disposed, as, in some degree, to prevent the blood flowing back to the veins, and to facilitate its passage into the ventricle.

The right ventricle thus becomes distended with blood. This cavity is placed before and on the right of the other ventricle, from which the septum ventriculorum divides it. It is broader, but not so long as the left ventricle, and altogether it is larger, and holds more. The muscular structure of this cavity forms a much thicker coat than it does in the auricle.

From the margin of the ostium venosum, a membrane firmly attached to its inner circumference, projects some way into the cavity of the ventricle. This membrane is broader in three places than in others, which, of course, project farther into the cavity; from these projections of its edges, and its use, the name valvulæ tricuspides has been given to it. Dr. Hunter considering it as a single membrane, thought valvula tricuspis a better name. It also has been called annulus valvulosus.

Strong but slender white cords are attached to its loose edge, these are named cordæ tendineæ cordis: the other extremities of these cords are connected with muscular pillars, which are attached to some part of the inner surface of the ventricle; these are termed the carneæ columnæ cordis.

That portion of the membrane which is on the side nearest to the pulmonary artery, and which is the broadest and most projecting, has in general the largest of the carneæ columnæ attached by their cordæ tendineæ to it, and while the right ventricle is filling, this portion of the valve closes the opening, and prevents the blood from flowing into the pulmonary artery, as the whole of the valvulous membrane, at that time, lies close to the sides of the ventricle.

The ventricle, when filled, contracts; the carneæ columnæ contracting at the same instant, pull the loose edge of the membrane from the sides of the cavity, the blood pressed on, passes between the valve and the surface it was withdrawn from, and the projecting points of the membrane meet so as to close completely the passage through which the blood passed from the auricle. The contraction of the carneæ columnæ also prevents the valve from being forced in an inverted state into the auricle, which might have happened, had only tendons been attached to it, and from it to the sides of the ventricle. If tendons only had been placed here, they must have been of a length equal to both the carneæ columnæ and cordæ tendineæ when joined; they therefore would have been too long when the ventricle contracted, and this would have allowed the valve to be inverted and pushed so far into the auricle, that some blood must have returned to its cavity; but the carneæ columnæ being muscular, shorten themselves proportionably to the contraction of the ventricle, and prevent this by keeping the valve within it.

The blood, from the above-mentioned circumstance must of necessity be propelled into the pulmonary artery, as the contraction of the carneæ columnæ removes the portion of the valve which covered its opening while the blood flowed into the ventricle. The passage of the blood into the artery is also facilitated by the surface of the ventricle becoming smoother towards its opening.

As the blood does not flow in one uniform constant stream from the auricle into the ventricle, as it does from the venæ cavæ into the auricle, and as the auricle is empty when the ventricle begins its contraction, a valve becomes absolutely necessary to prevent the blood from being propelled back into the auricle.

The constant stream in which the blood arrives at the heart, acts as an opposing force to the attempt that would be made, by the contraction of the auricle, to propel blood back into the veins, and renders valves at their entrances unnecessary.

The inner surface of the ventricle, (excepting the part near the origin of the artery,) has numerous packets of muscular fibres, with large and deep spaces between them, and of different sizes as to length and thickness, running and attached in every direction. These muscular packets have been termed lacerti.

These numerous and irregular packets of muscular and tendinous fibres on the inner surface of the ventricle, have had assigned to them the uses of mixing the chyle thoroughly with the blood; preventing the blood from stagnating, &c.; but none of these uses account in a satisfactory manner for their formation.

Foramina Thebesii are found on the inner surface of the right ventricle ; but they neither are so numerous, or so large, as they are in the right auricle.

Every part of the inner surface of the ventricle is lined by a fine and dense membrane.

LECTURE V.

HEART CONTINUED.

THE blood is forced by the contraction of the right ventricle into the pulmonary artery, which arises from the upper and back part, but towards the left side of the ventricle; it crosses the origin of the aorta, passes under the arch of that vessel, and divides into the branches going to the lungs in each cavity of the chest.

The term ostium arteriosum has been applied to the boundary of the ventricle at the origin of the pulmonary artery. There is a smooth and white appearance of the inner surface of the ventricle at this part, which some have supposed to be of a tendinous nature, and have called it the tendo cordis arteriosus,

From the boundary where the heart is joined to the artery, the semilunar or sigmoidal valves arise; they are placed there as flood-gates to prevent the blood from returning into the ventricle. These are usually three in number; I have once or twice met with no more than two. From their situation they are generally considered as belonging to the artery; but from their use I think it right to describe them with the heart.

Each valve, as the name expresses, is of a semilunar shape, and is attached by one edge, which is very convex, to the inside of the boundary between the heart and artery; the other edge is concave, but in a less degree so than the attached edge is convex; this edge is loose and turned towards the artery.

The cornua of each valve are placed in contact with the cornua of the others; they all run some way into and are attached to the inside of the artery; this prevents the inversion of the valve when shut. The loose or straightest edge of each valve is somewhat rounded, and is a little thicker than the rest of the membrane. In the middle of the loose edge there generally is found a small conical body, this has been called corpus sesamoideum aurantii. Such bodies are found more certainly in the valves of the aorta than in those of the pulmonary artery. The corpora sesamoidea, in the shut state of the valves, close up the passage between the artery and ventricle more perfectly.

Each valve thus forms a pouch with the artery, the mouth opening towards the artery, and the bottom being placed towards the heart.

The membranous part of these valves is inelastic, and therefore they are not formed merely by prolongations of the inner coat of the artery.

When the blood flows from the heart, the valves line the inside of the artery; when from the re-action of the elastic fibres of the artery, the blood is pressed on and attempts to return to the heart, it flows into and distends the three pouches, and in this manner the passage from the heart to the artery is closed. There is some appearance of a fibrous structure in the valves, which has been considered as muscular; and, as some of the fibres run nearly transversely, and others from the base of the valve to the corpus sesamoideum, the use ascribed to them has been that of drawing back the valve and opening it. I have not ascertained by personal observation or experiment that these fibres possess contractile properties; but if they are muscular they may act both in the opening and closing of the valve: muscular fibres always acting in a straight line. When the valve is shut, which must be the case when the ventricle is filling, upon the ventricle beginning its contraction, as the surface of the valve towards the middle of the cavity of the artery is convex, these fibres, in shortening themselves, will begin to draw the valve from the centre of the cavity of the artery; this action having commenced, the current of blood, rushing through, drives the valve against the inner concave surface of the artery, so that the valve lines it; the surface of the valve, which was concave in the shut state, becoming equally convex in the open state. When the artery begins its contraction, the fibres of the valve begin to draw it from the sides of the artery, and the blood, being forced by the pressure of the artery in every direction, rushes into the space between the valve and artery, distends the pouch, and all the three valves being so acted on at the same moment, meet in the middle of the cavity of the artery, and completely close the passage back to the heart. The loose edge of the valve will therefore be drawn towards the inner surface of the artery, when the ventricle begins its contraction, and toward the middle of the cavity of the artery, when the artery contracts. Unless the opening into the artery was closed during the time of the ventricle filling, the ventricle would never be distended.

The blood is thus forced through the lungs, and having undergone the necessary change, is returned by the four pulmonary veins, into the left auricle of the heart. This cavity is placed more backwards than any other part of the heart, and therefore when the pericardium is opened it is the least seen. The left auricle is thicker in its muscular coat than the right auricle; it possesses an appendage, but one much less in size, although more projecting from the general cavity. This appendage rests upon the upper part of the left ventricle, its edges are more irregular as it makes two or three serpentine turns. The musculi pectinati belonging to the right auricle are found only in this appendage. The inner surface of the rest of the cavity is much smoother and more regular than that of the right auricle, and its capacity is less: the proportion has been found to vary; but on an average it is rather less than one-third smaller.

The left side of the septum auriculorum wants the appearance of the fossa and annulus ovalis; the membrane which formed the valve in the fœtus, is continued in the same line with the rest of the septum; but the septum is, at the part formed by it, very thin.

The pulmonary veins open into the sides of the left auricle; two coming from each lung. These veins enter nearly opposite each other; on each side, the upper vein inclines a little downwards, and the under one a little upwards.

The capacity of the four pulmonary veins has been found to be rather less than that of the trunk of the pulmonary artery; consequently, the velocity of the blood's motion in them must be greater than in the artery; but as the coats of the left auricle are thicker and stronger than those of the right, they are thus adapted to the force of the current entering by the veins. The blood arriving at this auricle in four constant and continued streams, this circumstance prevents the necessity of valves being placed at the entrances of the veins, to hinder it from returning to these vessels when the auricle contracts; the contraction also here, as in the right side, begins from the points where the veins enter.

Although we should not expect to meet with Foramina Thebesii in the left side of the heart, as they are known to be the entrances of veins returning dark coloured blood; they are, notwithstanding this, met with in the left auricle, and sometimes in the left ventricle.

The ostium venosum of the left side, is situated on the anterior part of the left auricle: the surface of the auricle near to this opening, is smooth, and of a white colour.

The shape of this opening into the left ventricle, is oval, and the size of it is less than that on the right side; but the velocity of the current of blood being greater from the increased number and power of muscular fibres belonging to the left auricle, as much blood will pass through it in the same time, as passed through that on the right.

The left ventricle is placed before its auricle, and behind and on the left side of the right ventricle. It is a little longer than the right ventricle, so as to form the longest projection, when the apex of the heart is bifid, as sometimes is the case. The cavity of it is not so wide, and the capacity of it altogether, is less than that of the right ventricle.

The comparative size of the different cavities of the heart, cannot be measured with exactness, on account of their irregularity of surface, therefore any calculation on this subject, cannot be expected to be accurate; but from some experiments made with a view to determine this, the left ventricle has been conjectured to be less capacious than the right, in the proportion that 31 bears to 33; from other experiments, as 18 is to 20; from others, as $7\frac{1}{2}$ is to $10\frac{1}{2}$; this proportion varies in different people, at different periods of life. In a fœtus there is very little difference; but much in an adult, and disease often alters the natural proportion.

The membrane projecting into the cavity of the left ventricle from the ostium venosum, is continued from every part of the oval opening; but this opening being smaller than that on the right side, the points where it projects are only two in number. This has occasioned the term valvulæ mitrales, to be applied to the valve, from its resemblance to the mitre. Dr. William Hunter called it the valvula mitralis. The projecting parts are longer and stronger than those of the other side, each sending off, from the loose edge, many cordæ tendineæ which are attached to two carneæ columnæ, and these again to the sides of the ventricle. Sometimes there shall be more than two carneæ columnæ, but when so, two are always larger than the others.

The right projection of the mitral valve is the largest; it is placed between the ostium venosum and the origin of the aorta, so as to prevent the blood entering the aorta while the ventricle is filling; but when the ventricle is full, and begins to contract, it leaves the mouth of the aorta open, meets the other projection, and with it closes the passage to the auricle.

The inner surface of this cavity is rendered very irregular by the muscular fasciculi, which are smaller but much more numerous than in the right ventricle.

The thickness of the parietes of the left ventricle, from the number and arrangement of muscular fibres composing it, is more than double, often three times that of the right side; and the force which it is capable of exerting on the blood is proportionably great; the right ventricle propelling the blood only through the short course of the lungs; the left propelling it throughout the whole body.

The septum ventriculorum being formed of muscular fibres, belongs most to the left ventricle: this remark applies both to its thickness and length.—The surface of the ventricle becomes smoother near to the origin of the aorta.

The aorta begins at the upper and back part of the left ventricle, towards the right side of that cavity. At its origin, three semilunar or sigmoidal valves are placed, in a similar manner to those which have already been described as belonging to the pulmonary artery; but they are larger, thicker, and stronger. The corpora sesamoidea are more distinct in these valves, and the fibres said to be muscular are more evident.

The aorta forms a swelling outwards, corresponding to each valve; this, Haller calls the sinus of the artery.

The aorta leaves the left ventricle nearly opposite to the fourth dorsal vertebra, at first in a direct course from the base of the heart; but soon begins to form its arch, or great curvature, by ascending, then bending backwards, and to the left side, afterwards descending and reaching the spine. The highest part of the arch is opposite to the second dorsal vertebra.

The muscular fibres of the auricles are placed under the pericardial coat, and in some places are arranged with great regularity. In other parts, they form the musculi pectinati. On the septum, and about the tuberculum Loweri, Eustachian valve, and openings into and from the auricle, they have a particular arrangement.

The muscular fibres belonging to the ventricles, which are situated immediately under the pericardial covering, seem to descend from the roots of the large arteries, taking an oblique direction from the right side downwards and forwards to the left; they appear to pass over the side of the left ventricle and apex, and to be reflected to the base again, along the under surface of the ventricle; but some seem also to terminate at the apex, in a firm mass.

Within these, but blended with them, and running rather more transversely, but irregularly so, are packets of fibres arising from the outer circumference of each of the ostia venosa ; some of these fold inwards, and form the septum ventriculorum, and if we look on a tranverse section of the two ventricles, the fibres are so disposed, as to give the appearance of three bags, one of these containing the two others, of which one belongs to each of the ventricles, and the surface of contact between them, forms the septum. The exact course of these fibres cannot easily be traced.

On the inside of each of these contained, bags the fibres form the lacerti and the carneæ columnæ ; these have been already described. The general effect of the contraction of these fibres is to diminish, in every direction, the capacity of the cavities of the heart.

The term systole has been applied to the contraction of the ventricles, and diastole to their expansion or filling. The two ventricles have their systole at the same instant, they also have their diastole together.

In the systole of the ventricles, the blood being every where pressed on, excepting where the arteries open, is forced into the cavities of these vessels; the tricuspidal and mitral valves closing all communication with the auricles, at this same period the blood flows from the veins into the auricles ;

so that when the ventricles have their systole, the auricles and arteries have their diastole.

The diastole of the arteries is not produced merely by the relaxation of their muscular fibres; but is produced by the muscular contraction of the ventricles forcing the blood into them, and thus distending them.

During the systole of the ventricles, the apex of the heart, by the shortening of the muscular fibres, is made to approach the base.

The heart is lengthened again and thrown forwards and to the left side by the blood rushing into the ventricles from the auricles, and this direction forwards and to the left also assisted by the re-action of the elastic matter in the coats of the two large arterial trunks, more particularly that of the aorta, pressing upon the blood which has just been received from the ventricles, the sigmoidal valves closing prevent the blood returning to the ventricles; but the pressure of it against them throws the ventricles forwards, and adds to the force with which the apex strikes against the ribs: the incurvated shape of the arch of the aorta adds to the force of this stroke.

I have already stated, that the size of the different cavities cannot be measured with accuracy, on account of their irregularity of surface; this renders it extremely difficult, if not impossible, to ascertain with what force their muscular parietes would act.

To shew what different results have been drawn from experiments, supposed to be nearly infallible by those who made them, I shall instance two or three.

Borelli, having taken for granted that the absolute power of muscles was in direct proportion to their weight, and having ascertained the power of his deltoid muscle, compared his weight with that of a human heart, and following the proportion of power to weight, calculated that the absolute power of the heart was equal to the weight of 180,000 lbs. His calculation was built upon a wrong principle; it is not true that the power of muscles is in the direct proportion to their weight; for it is well known that habituating a muscle to a certain action, will increase its power far beyond that of a muscle more weighty, and similarly attached, but which has been less used.

Keil, endeavouring to estimate the force of the heart from the presumed, but not ascertained, velocity of the blood, made use of a theorem drawn from the principia of Newton, and taking what he thought other necessary circumstances into consideration, concluded that the force of the heart was only equal to five ounces. Keil also tried another mode of calculation, founded on the nature of the curve which the blood describes in spouting from the vessels upon their being divided, and by this mode made the force of the heart's action equal to eight ounces.

Hales endeavoured to estimate the force of the heart, by fitting a tube into an artery of a living animal, and observing how far the blood rose in it when placed perpendicularly. He tried this experiment on several animals, and found that the height varied according to the species of the animal. When the tube was placed in the crural artery of a horse, the blood rose nine feet six inches; in a sheep, six feet six inches; in a deer, four feet two inches; it varied from six feet eight inches to three feet one inch in different kinds of dogs. Taking these circumstances into consideration, and founding his calculation upon the supposed known surface of the left ventricle, his result was, that the force of the heart in a man, was equal to the pressure of 51 lbs. Hales's experiments, however, cannot be considered as faultless. They were not made on the beginning of the aorta; the inner surface of the ventricle could not be accurately measured; and the pain as well as terror which the animal experienced at the time, must in all probability have materially altered the natural force of the contraction of the heart.

These experiments have been varied by several physiologists, and the different conclusions which have been drawn from them, prove, at least, that the force of the heart cannot be known by applying mechanical principles to the actions of a living animal body. Many circumstances connected with the circulation, so far as the heart is concerned in it, cannot be ascertained with such precision as to form any mathematical proof. To calculate upon certain principles the force of the heart, we should know the exact quantity of blood which that organ at every contraction throws into the artery,—the exact period of time in which this is effected,—all the resistance from attraction to the coats of the vessels, which the heart has to overcome in moving the blood, which as the mass of it cannot be actually calculated, we cannot ascertain,—the comparative quantity of blood in the arteries and in the veins,—the bendings of the vessels,—their angles,—their conical shape,—the elastic and contractile properties inherent in themselves, as well as in the parts near them or surrounding them. The knowledge of all these circumstances being necessary to ascertain the force of the heart's action, obliges us to conclude with Haller, that it must be considerable; for the entire mass of blood when at rest, can be set into motion by the force of the heart alone, as in the instance of persons recovering from fainting, swoons, or any other cause producing suspended animation.

The muscular fibres of the heart, it would appear from a fact recently mentioned to me by professor

Coleman of the Veterinary College, may from over distention lose the power of contraction, and thus produce death. He found on opening the chests of some animals which had been hanged or drowned that the right auricle and ventricle of the heart were completely turgid with blood, and that no contraction took place in the auricle upon irritation being applied to it; but on opening one of the veins, and allowing some blood to escape, after a few minutes the auricle, upon irritation being applied, again contracted. I have opened the bodies of three or four people who died suddenly, and have found the right side of the heart completely filled and very turgid with blood, when no other appearances different from what are usual were met with. It is well known that the muscular fibres of the bladder will lose the power of contraction after having been gradually over-distended by the quantity of urine sent to that viscus, and kept long in that state. In the above quoted instances, a similar effect seems to have been produced in the heart, by a sudden over-distention of its cavities.

The heart receives the blood for its immediate nourishment from two arteries named the arteriæ coronariæ cordis, which arise from the aorta immediately above the loose edges of two of the sigmoidal valves. The orifices of these arteries will always appear above the edges when the valves are placed against the inner surface of the artery while it continues in its cylindrical shape ; but when the artery is slit open and flattened, the edges of the valves will appear to cover the openings of the coronary vessels ; and this, I presume, has deceived those anatomists who have stated, that the valves must be closed before the blood can enter the coronary arteries.

The left coronary artery is nearly two thirds larger than the right, as it has to supply a thicker mass of muscular fibres. It arises from the left side of the aorta, and runs forwards between the pulmonary artery and appendix of the left auricle, to both of which parts it sends small ramifications. It soon divides into two branches, one of which passes obliquely forwards, nearly in the direction of the upper part of the septum ventriculorum, until it reaches the apex, sending in its course, some very small vessels into the substance of the right ventricle, and two or three large branches to the upper surface and sides of the left. These and all the other branches of each coronary artery are more or less convoluted during their whole course.

The other branch of the left coronary artery is continued in the angle between the auricle and ventricle, until it reaches the under part of the septum ventriculorum at its base, being in contact during the latter part of its course with the coronary vein; it continues to send off convoluted vessels, which run towards the apex of the heart.

The right coronary artery arises from the forepart of the aorta, it then passes downwards and to the right side in the angle between the auricle and ventricle, supplying the adjacent parts of both with blood; its largest ramifications pass forwards. It anastomoses with the left coronary artery, at the part immediately below the base of the septum, and has some small branches extending nearly as far as the apex the heart.

The blood is returned from the substance of the heart by a vein, named the vena coronaria cordis, the trunk of which is formed by branches coming from almost every part of the heart; it is placed in the depression between the auricle and ventricle of the left side, in this it runs until it reaches the space between the entrance of the vena cava inferior and the ostium venosum, and it terminates in the right auricle between these great openings. A large branch coming from the apex of the heart, and running along its under surface, joins the trunk immediately before its entrance into the auricle.

There are other veins, varying in number and size, from the upper part of the right ventricle, which enter separately the anterior part of the right auricle: the largest of these have been known by the designation of venæ innominatæ Galeni.

I have already mentioned, that blood passes from small veins into all the other cavities of the heart through the foramina Thebesii.

The general appearance of the veins is much less convoluted than that of the arteries.

The absorbent vessels on the surface of the heart are very numerous, and may be easily discovered by maceration in water for a few days; they will then be filled with a gaseous fluid generated in the cellular membrane by putrefaction. These absorbents ramify in a particular manner, something between the arborescent appearance of those on the surface of the liver, and the reticular distribution of those on the surface of the lungs. Two trunks are formed, the largest of which is on the left side; this runs for some little way in the space between the auricle and ventricle, it passes under the pulmonary artery, and extends upwards behind the middle of the arch of the aorta, it then enters one or more glands near the lower part of the trachea, the vasa efferentia of which enter the thoracic duct near its termination.

The absorbent trunk from the right side of the heart passes upwards on the forepart of the aorta; it then passes over the arch of that vessel, sometimes between the origin of the two carotid arteries, and enters one or more glands situated behind them; the vasa efferentia of these glands generally enter the right trunk of the absorbents, but I have known them join the thoracic duct; and have also seen them pass into both of these terminations of the absorbent system.

It is not an easy matter to unravel the whole of the connections, which the nerves belonging to the heart have with each other, as they proceed towards it from the brain and the cervical trunks I have, from my repeated dissections of the nerves in the neck, found them subject to much variety in shape, ramification and connection.

The intercostal and parvagum are the principal trunks from which the heart is supplied. When the middle cervical ganglion of the intercostal exists, small nervous branches, two or three in number, pass downwards under the carotid arteries towards the heart; when the middle cervical ganglion is wanting, similar nervous branches come off from the inner part of the lower cervical ganglion; these are also found when the middle cervical ganglion exists, these branches communicate by small filaments with each other. In their passage towards the heart they are joined by a filament sometimes of a very distinct and perceptible size, which comes off from the eighth pair, a little below the middle of the neck; other filaments come off from the same trunk, but nearer to the heart, which join those arising from the intercostal, and by their union form the plexus cardiacus, which plexus, crossing over the bronchiæ, passes on to the heart in the direction of the large arterial trunks, sending off previously ramuli to the pericardium. Filaments of communication also pass between the plexus of the right and the left side.

It is not unusual to find a small nerve sent off from the upper cervical ganglion, which runs down with the carotid artery, and having communicated with the glosso-pharyngeus nerve, also with the trunk of the eighth pair, and even with the descending branch of the ninth, joins the cardiac plexus, from which the nervous filaments pass on to the substance of the heart. I have traced nervous filaments from the three lower cervical nerves, which also having joined the cardiac plexus, went on to the heart.

It is well known, that the muscular structure in those viscera upon the constant action of which life depends, is not supplied with nerves of so large a size, as the same quantity of fibres forming muscles of voluntary motion seem to require; it is also well known that these viscera have their nerves always sent from the parvagum and the intercostal, which nerves form plexuses with each other, and are occasionally joined by plexuses coming from other trunks; but it is not so generally known, that there is more intricacy in the internal structure, or rather arrangement of fibres in the parvagum and intercostal, than in any other nerves.

In other nerves, the packets of fibres are arranged with the appearance of regularity, and run in a direction parallel to each other; but in the parvagum and intercostal, the packets composing the trunks and larger branches, are very irregular, both as to size and the course of their direction; they connect themselves with each other, so that when the trunk is unravelled and spread out, they put on much the same appearance that plexuses do in other parts of the body. Mr. Charles Bell has shewn this structure in some preparations of the parvagum and intercostal nerves, made by him, and now preserved in the Museum in Windmill Street.

Muscles, or rather muscular fibres supplied by these nerves, are not under the influence of volition, but are capable of being strongly affected by emotions of the mind, and will often act in direct opposition to the will. They begin their action before we are conscious of our existence; and they go on acting for life without producing the sensation of fatigue.

The immediate cause of the circulation of the blood is the alternate relaxation and contraction of the muscular fibres of the heart; but when we inquire into the causes which keep up these actions, we are lost in boundless conjecture.

The heart is certainly more irritable than other muscles, and it preserves this irritability for a much longer time after the death of the animal. That it contracts from this irritability there can be no doubt; for stimuli of various kinds, applied to its substance, will produce its instant contraction; but when applied to the trunks of the nerves which are going to ramify in its substance, at some little distance from it, they will produce no effect whatever. I have seen the voltaic influence used for this purpose, by Professor Aldini, without the least sensible motion in the heart having been produced by it, when applied to its nerves; although for a very long period afterwards, it excited violent contraction in the diaphragm and other muscles when applied to the trunks of the nerves supplying them.

I have likewise seen both mechanical and chemical irritations applied to the nerves going to the heart, without producing the least effect in exciting its contraction; and I have seen the same heart, (which was that of a turtle,) excited to contract, by being irritated with the point of a sharp instrument applied immediately to its substance, twenty-three hours after it had been removed from the body of the animal. In amphibious animals, the irritability of the heart remains much longer than in the more perfect quadruped.

It has been fully ascertained, that the hearts of many classes of animals, after all communication with the brain or lungs has ceased, can be stimulated to contract, by heat, by air, by any mechanical irritation applied to their external surface, or by any warm fluid injected into their cavities; and, from many experiments it appears, that the most irritable part of the heart, and that which continues to preserve its irritability longest, is the apex. The next most irritable part is the septum ventriculorum.

From many experiments made by several physiologists, among whom appear the names of Mr. William Cruikshank, (my ingenious and much regretted master, and afterwards colleague in the School of Anatomy in Great Windmill Street,) and Professor Bichat, in which the parvagum and intercostal nerves were tied or divided without producing the death of the animal by the immediate stoppage of the circulation,—it has been doubted, whether the contraction of the heart does at all depend upon its nerves; and this doubt has been strengthened by the heart remaining irritable, so as to contract when stimulated, long after it has been removed from the body, and when all the influence which it might have derived from the brain, may reasonably be supposed to have been consumed or lost.

These experiments have proved that the brain is not directly necessary to the action of the heart; in addition to this proof I may observe, that the human fœtus has been born at the full time, perfect as to the heart, but completely deficient as to the brain.

The circulation of the blood and the action of respiration are so interwoven, that the stoppage of the one is always found to be attended with the failure of the other. In one of John Hunter's experiments on artificial breathing, in a dog, he found that the heart soon ceased to act whenever he left off using his bellows; but that, upon renewing the artificial breathing, the action of the heart also returned. He therefore infers, that the nearest dependance of the heart is upon the lungs, and he thinks, that this dependance is reciprocal, although we cannot have a direct proof of its being so, as we cannot, he says, make an artificial circulation so as to know that if we stopped the heart's motion, we should so readily stop respiration, and on producing the heart's motion, respiration would again take place; because, he believes, in all deaths, respiration stops first. John Hunter, in farther proof of this, mentions an occurrence that happened to himself, in which, he conceives, his life was saved by his making respiration a voluntary action; both the heart's action and breathing having stopped for some little time.

Some Physiologists have considered the blood as the only necessary stimulus to the heart; but the heart of an animal has been seen to contract and relax, after the blood has been completely removed from its cavities, and all source of a fresh supply cut off; this proves, that the blood is not the only stimulus.

The experiments made by Mr. Brodie, and which he communicated to the Royal Society, in the Croonian lecture given by him in 1810, confirm the opinion that the brain is not directly necessary to the action of the heart; and that, when the functions of the brain are destroyed, the circulation ceases only in consequence of the suspension of respiration; and further, that when the brain is injured or removed, the action of the heart ceases, only because respiration is under its influence, and that if under these circumstances respiration is artificially produced, the circulation will be renewed and go on.

Mr. Brodie's experiments were made, and much varied on rabbits and dogs. Having secured the blood vessels in the neck, he cut off the heads of several of these animals, and imitating respiration, by using a bellows of a particular construction, the pipe of which was inserted into the trachea so that the lungs could be alternately filled with and emptied of air, he found, that the heart continued to contract, apparently with as much strength and frequency as in a living animal; and that the blood underwent the usual change from the dark to the florid colour, in circulating through the vessels of the lungs.

In the first of these experiments made on a rabbit, the artificial breathing was continued twenty-five minutes; in the second, made on a dog, two hours and a half. After one hour and thirty minutes the pulse had risen to eighty-four in a minute; after two hours the pulse had fallen to seventy; and when the artificial respiration was discontinued, the pulse had fallen to thirty-five.

In the third experiment, in a rabbit, respiration and circulation were continued an hour and forty minutes; in the fourth, in a dog, one hour and twenty-five minutes; in the eighth, in a rabbit, one hour and forty minutes, at the end of which time, the pulse was ninety in a minute, and the artificial respirations were not continued after this period.

In Mr. Cruikshank's experiments, when the parvagum and intercostal of each side were divided, the dog died in twenty-eight hours. When the nerves were divided on one side only, distressing symptoms took place, but the animal recovered; and on future inspection, the nerves which had been divided were found to be united, and where a piece had been cut out, to have been regenerated; so that, on the division of the parvagum and intercostal of the other side, the animal lived, in one instance, seven days, and in another, was killed at the end of twenty days.

Many years ago I witnessed some experiments made by Mr. Otto, on the effects produced by dividing various nerves. He repeated and varied the experiments made by Mr. Cruikshank, and the result of his experiments was, that when the parvagum and intercostal were divided on both sides in the neck the animal died after a few hours; when the division was only on one side the animal recovered; but in every instance, although in one case, a year had elapsed before the nerves on the other side were divided, when they were divided, the animal soon died.

Monsieur C. Gallois has asserted, that although the heart of an animal, after its head has been removed, will, by artificial breathing, possess the power of circulating the blood for a considerable time; yet if the spinal marrow is also immediately destroyed, that power ceases. I have lately understood from Mr. Brodie that this is confirmed by an experiment made by him. This can only be accounted for on the supposition of some influence reaching the parvagum and intercostal from the spinal marrow, necessary perhaps for the important change which the blood must undergo in the lungs; for the heart itself will contract for hours when removed from the body.

Mr. Cruikshank's experiments do not exactly coincide with the result of the one made by Mons^r. C. Gallois, but in Mr. Cruikshank's experiments the spinal marrow was not destroyed, it was merely divided between the neck and back.

Mr. Cruikshank divided the spinal marrow between the lowest vertebra of the neck and uppermost of the back, and the dog died in twelve hours.

In another dog Mr. Cruikshank divided the parvagum and intercostal on each side, also the spinal marrow between the lower cervical and upper dorsal vertebræ, and the animal died in ten hours after the operation.

In another experiment the phrenic nerves were divided, quarter of an hour afterwards the spinal marrow between the lowest cervical and upper dorsal vertebra were divided, and the dog died instantaneously; but on the lungs being inflated with air the heart began to beat 70 times in a minute, and this was continued for half an hour. The diaphragm contracted on irritation being applied to the phrenic nerves which remained below the divided parts, and the œsophagus contracted on the parvagum being irritated; but the heart would not contract after the inflation of the lungs had ceased, by any irritation applied to its nerves. I have, however, already stated that irritating the trunk of the nerves, does not affect the contraction of the heart after the apparent death of the animal.

From the experiments which I have quoted, it appears, that the irritability in the heart is a property distinct from immediate nervous influence, and, most probably, it has been so ordained by nature, that existence should not be hazarded by any temporary cessation of that influence which might arise from pressure, or other causes acting on the nerves communicating between the brain and those organs whose constant and continued actions are necessary to life. But after birth, the dependance of the heart, brain, and lungs on each other is so great and mutual, that life cannot be continued beyond a limited time when either of these systems has been destroyed.

LECTURE VI.

ON THE ARTERIES.

The heart, although fixed in its situation, is an organ, whose influence extends to the most minute and distant parts of an animal body; it may be truly said to dispense life and health to all; in its essential and important functions, it is assisted by the arteries, which are flexible tubes arising from it, ramifying throughout every part of the body, and forming channels, along which the blood is propelled every where. The arteries also have the power of selecting, separating, and depositing materials mechanically mixed with the blood, and in certain structures, viz. the glands, of forming new fluids from the blood, whose elements, although not combined, were contained in it. They thus are employed for the purposes of forming, increasing and nourishing the body, of creating other bodies, or of removing from the body substances, which by remaining might prove injurious to it.

The arteries after death, are distinguished from veins by their coats being whiter, more opaque, and of greater thickness; by their having no valves excepting at their immediate origin, and by their possessing so much elasticity as to enable them to preserve their cylindrical form, although empty.

They are distinguished, during life, by the colour of the circulating blood, the course of its stream, and by their beating or pulsatory motion.

Arteries are found to possess three coats; but these coats are united by fibres and vessels so as to appear at first sight one solid mass: there is no apparent looseness of texture to sanction the division; but the different laminæ upon minuter inspection become unquestionable. These are termed the external, the muscular, and the internal coats.

The external and muscular coats form a very large proportion of the whole, and are less distinct from each other than the muscular and internal; this may be seen in a longitudinal section, but much better on a transverse section of an artery. Haller divides the coats of an artery into five; but as two of these are formed merely by cellular membrane, which is to be considered as the universal connecting medium of the body, the first and fourth of his divisions may be rejected as unnecessary.

Arteries receive occasional and partial coverings from membranes in their vicinity, such are those from the pericardium, the pleura, and peritoneum.

If we examine the cut surface of an artery of such size as will admit of a visible distinction of parts, the outer and muscular coats do not appear to differ much from each other, but still some difference in colour and solidity may be perceived.

The distinction between them is much more evident as the branches become smaller and are further removed from the aorta. In the aorta there is but little difference; but in the popliteal artery the difference is very manifest. It is therefore ascertained, that these two parts do not bear the same proportion to each other in the larger as in the smaller arteries; for the denser, darker coloured or muscular coat is met with in much the largest proportion in the smaller arteries.

In the external coat, we can perceive fibres, which towards the outside, and where ramifications are sent from the trunk, are very irregular and uncertain in their direction; but nearer to the muscular coat, they become more regular, and arrange themselves in packets having something of a transverse or circular course. These fibres possess great elasticity. In other respects this coat appears to be formed chiefly of cellular membrane, which towards the outer circumference of the artery is loose, for the purpose of connection with the parts surrounding it, and becomes more and more condensed and firm towards the middle or muscular coat of the vessel.

The property of elasticity possessed by this coat is materially different from the power of muscular contraction resident in the middle coat of the artery. Elasticity is found in many living and dead animal and vegetable substances, as well as in other bodies which never did or could possess the properties of life. It can begin no action, it disposes parts to remain constantly at rest and in the same form ; but when bodies endowed with it have been acted on by some mechanical power, it tends to restore them to the figure which they had lost.

In a living animal body, elasticity is occasionally used to restore parts to a medium state, either when they have been too much stretched or too much contracted by muscular action. In the arteries, it sometimes aids and sometimes opposes the muscular property. The natural form of an artery when at rest and unacted on, may be considered as that which is produced by elasticity.

The blood, thrown into an artery from the heart, increases the extension not only of its circumference, but also that of its length ; elasticity returns it to its former state. It is elasticity which produces the instantaneous retraction of the cut surfaces of an artery when divided in a living animal ; and as very few, if any packets of fibres are seen to run longitudinally, these instances prove that packets of elastic fibres are capable of lateral as well as rectilineal action.

John Hunter, when treating on the vascular system in his invaluable work on the blood, has given, in detail, many experiments made by him on the elasticity of arteries; the result of which proves, that the power of recovery in an artery, when altered from its natural state by any mechanical means, is greater in proportion as the vessel is nearer the heart; and that when farther from it, this power lessens. These experiments also clearly demonstrate the decrease of the elastic property in the smaller arteries, and the increase of the muscular power.

The colour of the muscular fibres in arteries is not red, but a light brownish yellow.

The fibres of the muscular coat have not that distinct arrangement, which the muscular fibres of the intestines possess; packets of fibres, however, which have contractile and muscular properties are very observable in some arteries, and can be demonstrated much more readily in the popliteal artery than in the aorta; but there is always much elastic substance similar to that in the external coat blended with them, which much increases the thickness of the second coat. In animals which have been bled slowly to death, the contraction of the muscular fibres has nearly obliterated the cavity of the artery, and has so far exceeded the contractile property of the two other coats, as to throw them both into folds of longitudinal direction.

It is difficult, if not impossible, to discover the precise direction of these contractile fibres. They in general appear to run transversely or circularly; but no single packet of fibres can be traced on, so as to form a complete circle, although the extremities of one packet being joined sideways to other packets, several of them when thus joined produce something of the appearance of a ring. Few, if any, of these packets appear to run longitudinally.

John Hunter says, he never could make out the precise direction of the transverse fibres, but supposes it to be oblique; because the degree of contraction sometimes has appeared to be greater than what could be produced by a straight muscle; in which light a circular muscle is to be considered, as its effects are in the direction of its fibres. The fibres of the muscular coat are easily separated from each other lengthways when the artery is stretched, but with great difficulty when the vessel is dilated transversely. This coat is joined to the internal one by a very fine and close cellular membrane.

Some anatomists have contended that there is no muscular coat belonging to arteries, and that they are merely composed of an elastic ligamentous substance. The late Dr. Nichol was of this opinion, and used the following argument in supporting it, viz. "That in hemiplegia the arteries of the affected side performed their functions, though the muscular power of the whole side was arrested."

This doctrine has lately been revived, but as the muscular contraction of the arteries can be demonstrated, and the fibres producing that contraction seen, I shall not take up your time by offering any further proof to confute this strange opinion, than desiring you to look on the arteries of an animal bled slowly to death, or on those which have been accidentally or intentionally opened, and from which there had been some considerable hæmorrhage; you will then distinctly perceive, on the inner surface, packets of fibres, the contraction of which had lessened the diameter of the artery. Preparations are preserved in our museum which demonstrate this truth.

The internal coat cannot easily be separated from the muscular. It is a thin, smooth, and finely polished membrane; these qualities it must possess to allow of a free circulation to the blood; and it is dense to prevent the transudation of it. It is supposed to possess some elastic and muscular properties, but in very limited degrees. The fibres belonging to it are not to be discovered by the naked eye, and are scarcely perceptible in the microscope, so as to be distinguished with accuracy from the fibres of the middle coat, some of which adhere to it. It lines the fibrous muscular coat, thus preventing the blood from insinuating itself between the packets, and is continued on from the valves where the artery joins the heart.

The coats of arteries are themselves vascular. The vasa vasorum can be injected to considerable minuteness in a young growing animal; and in an inflamed artery they are often seen in great numbers ramifying in the external and muscular coats; but previous to injection, or inflammation, the coats of an artery do not appear to be very vascular. These vessels were first described by Thomas Willis, then by Vieussens, and were afterwards more accurately delineated by Ruysch.

The arteriæ arteriarum arise from some neighbouring arterial trunks, and enter the coats of the vessel which they supply from the outside. Those which supply the aorta, do not arise immediately from the cavity of that vessel, but from the coronaries, the intercostals, the æsophageal, or the bronchial, and are reflected back to it.

The venæ arteriarum are equally numerous, and ramify in a manner similar to the arteries. In cases of inflammation of the coats of arteries the two sets of vessels may sometimes be distinguished by the florid and dark coloured blood which their cavities contain.

The absorbent vessels of arteries cannot be demonstrated so readily as the blood vessels, from their numerous valves preventing the injection flowing from the trunks to the branches. I have often injected a considerable number of these vessels clinging to and surrounding the large arterial trunks, and I cannot doubt of these trunks receiving branches from them; but the cavities of arteries enlarging, and the arteries preserving their relative proportions as the body grows, proves sufficiently that absorbents must form part of their vasa vasorum.

As nerves cannot be injected, and are not rendered more conspicuous by disease, it requires a little more trouble to trace them into the coats of arteries, than to trace the blood vessels. Plexuses of nerves are found in many places surrounding the large arterial trunks, and I have occasionally traced branches from nerves, so as to see them distinctly ramify in the coats of arteries. I can have no doubt of nervous filaments communicating with the packets of muscular fibres, as there is sufficient proof in the action of blushing, that these fibres are much influenced by emotions of the mind.

In the Philosophical Transactions of 1814, Sir Everard Home has stated that in an experiment made by him, in the presence of Mr. Brodie and others, by irritating the intercostal nerves, in the necks of dogs and rabbits, he produced a temporary increased pulsation of the carotid arteries. The carotid arteries were chosen as the only vessels of sufficient size, that could be easily exposed, into which nervous branches can readily be traced from the trunks.

In describing the heart, I have already mentioned the nature of the valves found at the beginning of each of the two arterial trunks. Valves are not met with in any other part of the arterial system.

Arteries appear to be cylindrical in shape, when no branches are sent off; but including the branches, they have been considered as conical. If an artery be traced from its origin to its termination, not including the lateral branches, the trunk, of course, forms the base of the cone; but when all the different branches are included, these have been considered as forming the base of the cone, and the trunk the apex of it. It has been found from experiments, that the branches into which an arterial trunk immediately divides, are more than equal to the trunk in capacity; two inches, for example, of the primitive iliac arteries, one inch being taken from each artery, are more capacious than an inch of the lower part of the aorta from which these vessels are sent off.

The branches of the aorta are so numerous and so distributed, that no part of our bodies is without them.

The proportion of the solid parts of an artery to the size of its cavity, is not the same in every part of our body; nor is it constant in the same artery. This proportion appears to be least at the heart, and increases as the arteries are further removed from it. Sir Clifton Wintringham's experiments on a dog, have proved this fact.

The thickness of the coats of an artery, to that of the coats of the correspondent vein, also varies. The thickness of the aorta descendens to that of the vena cava inferior, has been found to be as 510 to 97, in one experiment; and as 154 to 9, in another.

In the lower limbs, however, there is often but little difference between the thickness of the arteries and that of their corresponding veins.

From experiments which were made by Sir Clifton Wintringham, Haller, and others, on dead arteries, it appears that the strength of the artery, relative to its size, is greater as the artery is distant from the heart. In these experiments the aorta below the diaphragm, compared with the aorta above the diaphragm, possessed strength in the proportion that 1794 exceeds 1000. The iliac artery exceeds the aorta at the renal arteries, as 1897 exceeds 1000. The splenic, as 1319 exceeds 1000. The renal, as 51 exceeds 40.

But these experiments are by no means conclusive as to the strength possessed by living arteries; for in living arteries there are two powers existing in the same part, elasticity, to resist mechanical impulse—this power remains after death; and muscularity, to produce certain actions—this power ceases with life.

Mechanical strength is not so much wanted in the smaller arteries, as muscular strength: the strength therefore of these vessels in the living body appears to depend much on an action arising within themselves, which ceases with life.

John Hunter gives some strong instances of arteries retaining the power of muscular contraction long after the death of the body, and long after they had been separated from the heart of the animal. This is a property which the involuntary muscles possess to a greater degree than the voluntary, and arteries are to be classed so far as regards their muscular structure with the former. In this they resemble the heart, which can be excited to contraction, particularly in amphibious animals, many hours after its separation from the body. From the greater proportion of muscularity in the smaller arteries, this power continues for a longer period in them than in the larger.

The strength of the coats of an artery, is not equally great on all sides. In the great curvature of the aorta the upper convex part is the strongest. Arteries are likewise stronger at the sharp angles made by a trunk with its branches, and at the angle formed by a trunk when divided into two.

The only origin of arteries in the human body is from the ventricles of the heart; but in some animals the aorta arises from the vessels of the organ of respiration.

Arteries, in their course, are placed by nature in the safest situation, and at the greatest distance from exposure to external accidents, which might injure their coats, or stop the circulation of blood through their cavities. The larger trunks are therefore situated on the inside of limbs and pass over the bending side of joints. They generally take the shortest road to a part; but to this there are several well marked exceptions.

Arteries have much variety in their mode of ramification in different parts of the body. All the arteries are derived from two trunks; branches are sent off from these which divide into still smaller, and this division is continued until every part of the body is supplied by the ultimate ramifications.

In general the branches are sent off at acute angles, these being the most favourable to the free passage of the blood. The acuteness of the angle is very observable in the division of those arteries which are to convey blood to a distant part, and in those which are situated far from the heart. Near to the heart, some branches appear to arise at right angles, and a few, even at obtuse angles; but those branches which appear to make obtuse angles with the trunk, when carefully examined, will be found generally, if not constantly, to come off actually at acute angles, and that it is only from their immediately forming an inflection and altering their course, that they have the appearance of coming off at acute angles.

An ingenious argument has been suggested in favour of the angles of arteries and their courses being varied, viz. :—The force of the heart's action on the blood being strongest in the arteries nearest to that organ, the velocity of the blood's motion would be greater in the parts supplied by them, than in parts of a similar structure which were situated at a greater distance from the heart; but to keep up a velocity in the current of blood sufficient for all the different parts, and not more than sufficient, nature has varied the angle of the origin of the arteries at different distances from the source of circulation; thus, near to the heart some of the angles seem at first sight to be obtuse; farther from it, the angles are less and less so, till at length they become very acute.

The ramifications of arteries assume very different appearances in different parts of the body.

When two or more arterial trunks, or their branches, are joined by a continuity of canal to each other, they are then said to anastomose. Innumerable instances of anastomosis are met with in the smaller arteries, and some between vessels of a large size.

One obvious advantage derived from such communication of vessels is, that parts are enabled to receive a supply of blood, although, from some temporary or accidental causes, the circulation of it had been obstructed, or even completely stopped in the trunk which usually conveyed it to them; the smaller arteries are the most liable to these causes, partly from their situation, and partly from the circulation in them being carried on with less force; they therefore generally anastomose.

In parts, the actions of which are of importance to life, and where there is a chance of pressure occasionally retarding the circulation in any particular artery, the trunks or larger branches anastomose. But there are parts of importance to life where no anastomoses take place even in the smallest arterial branches, as in those of the pulmonary artery. Those of the bronchial artery, however, do anastomose.

The ramifications of some arteries put on the arborescent appearance; some the reticular; some the radiated; some are arched; some are reflected; some are convoluted; some run in a serpentine direction, and others are irregularly tortuous.

There are instances of arteries, which not only take a long course to the parts which they are to supply, but also increase in size as they are farther removed from the heart. We meet with instances of this kind in the arteries of the human placenta, and in the spermatic arteries of quadrupeds, particularly in those of the bull. This increase in capacity and length, we may reasonably conclude, is to answer some purpose peculiar to the parts to which the blood is conveyed; one effect of such structure and course, evidently, will be to render the circulation slower. Blood, frequently sent and with great force to an artery which is so attached, that it cannot remove its extremities in a straight line farther from each other, will render such artery tortuous; an increased muscularity is the necessary effect of this, to preserve to it the powers which it must occasionally exert. In dead bodies, when the arteries are very much filled with injection, they invariably become tortuous.

I may here notice that extraordinary structure, the rete mirabile in quadrupeds, where the carotid artery divides into branches of different capacities and lengths, which again unite, after having broken the force of the circulation before the blood reaches the brain; also the arrangement of axillary arteries mentioned by Professor Carlisle, in the sloth.

Arteries have various terminations; but, generally speaking, they may be said to terminate in veins, or in extreme branches endowed with a peculiar mode of action. These have been termed exhalant arteries, secerning branches, and in parts which are not glandular, they have been called by John Hunter, labouring vessels.

Arteries terminate usually in veins by a continuity of canal, so large, as to let the globules of blood readily pass through; but some branches are too small to admit the globules, these have been called lymphatic and seriferous arteries, these also terminate in small veins. Microscopical observations, ligatures on living and injections into dead vessels, prove this termination. The termination in veins, by a continuity of canal, has been discovered since the time of Harvey; for he supposed that the blood was poured from the arteries into a kind of spongy flesh called parenchyma, from which it was taken up by the veins.

The orifices of the exhalant, secerning, and labouring vessels have never been seen, even by the microscope; we judge, however, of their existence by effects: viz. fluids thrown out on surfaces, and materials lodged for the formation and support of the body.

Some arteries terminate in cells: as in those of the corpora cavernosa penis et clitoridis, and those of the maternal part of the placenta. Others terminate in glands, or in their excretory ducts, as in the tubuli testis, &c.

The degree of vascularity from arteries is different in different parts of the body, depending on the uses they have for blood. The most vascular parts are the organs of secretion; parts of organs of sense, which have a secreting power; or surfaces of canals which have external openings, and which always secrete; then muscles and bones; after these, ligaments, tendons and cartilage.

Arteries have the power of occasionally enlarging and diminishing, from natural causes, as in the gravid state of the uterus, and after delivery; they have this power, also, during and after certain diseases.

There is much variety in the arterial system, as to the number of arteries belonging to a part, the mode in which they divide their particular situation, and also in their origin.

There is at one time a greater, at another time, a less quantity of blood contained in the arteries; but whatever is the quantity, their cavities are always full, as these vessels are possessed of a power of dilating or contracting, so as completely to adapt themselves to their contents; should they ever be emptied so that their power of contraction should become unequal to this, the animal would die, as the circulation of the blood could no longer be carried on.

Arteries possess muscular fibres, not only to produce this adaptation, but also to assist the heart in carrying on the circulation of the blood. Arteries have been known in monstrous formations of the human fœtus to carry on the circulation without a heart, and in some imperfect animals, as has been formerly instanced, they constantly do this. This muscular power of arteries ceases with life.

Arteries also possess an elastic property, which tends to keep them at rest, and of a certain diameter and size; this property does not cease with life, for it remains until putrefaction takes place; and it is from this property that arteries retain their cylindrical form in the dead body.

The smaller and perhaps the middle-sized arteries never appear, to possess so large a diameter in the living as they do in the dead body. In the living body, these arteries are rather less in diameter than their elastic property would make them; but, in the dead, it has full scope of action, the property of muscular contraction having ceased with life; consequently, the diameter of these vessels in the dead is larger than in the living body.

In the bodies of animals which have been bled slowly to death, the arteries will be found contracted almost without a cavity; but upon stretching them, they will not return to that state; they will only contract so far as their elastic property impels them.

Elasticity appears to be of great use in the aorta, and its larger branches, in so far as it saves the exertion of muscular action; for when the heart throws the blood with great force into the aorta, and dilates that vessel beyond its natural or usual state, the elastic property, alone, may be capable of restoring the vessel to its usual diameter; or if not so, it must greatly assist the muscular fibres in accomplishing this; but if from loss of blood, or any other cause, the vessel is required to contract beyond this state, such farther contraction can only be effected by the muscular fibres, which will then act in opposition to, and have to overcome the elastic property.

It has been the opinion of some physiologists, that, in the natural healthy state of the body, the elastic property alone is equal to carry on, and is, in fact, the only property employed in carrying on the circulation, so far as it depends on the arteries, and that the muscular fibres are only used in extraordinary cases, as after much loss of blood, or when the blood is to be sent in larger quantities to any particular part, as to the cheeks in blushing, or to parts affected by local inflammation. In other words, that muscular fibres are given to the coats of arteries, to be ready to act should there be occasion for their action; but that unless some unusual action is required, the elastic property alone is employed to carry on the circulation, so far as it depends on the arteries. Thus by muscular exertion being saved, fatigue is lessened or prevented.

This is so in the larger arteries; but in the smaller branches, muscular exertion is required to carry on the circulation, and it is in these vessels that we find the muscular fibres the most evident. As the velocity and force of the circulation is greatest when nearest to the heart; in vessels which are so situated, muscular contraction can seldom be wanted; but the smaller and more distant arteries require, and possess more muscular power, on account of the force of the heart's action on the blood having decreased before this fluid reaches them, and also on account of their numerous anastomosing branches.

The muscular contraction in the smaller arteries, during life, keeps their diameter rather less than their elasticity would; therefore, when the muscular exertion, which they use to propel the blood on, ceases, the elastic property endeavours to distend their diameter, and effects this to a certain extent, but not to a greater degree than the quantity of blood in circulation requires.

Thus alternate contraction and extension take place in the lesser arterial branches, by the muscular and elastic properties being opposed to each other; while in the larger arteries, these properties assist each other; or the elastic property alone restores the artery to its natural diameter when it has been dilated beyond this by the action of the heart.

Cases however may occur, in which, from great loss of blood, the larger arteries may have contracted so much, that even in the aorta, the elastic property may be required to dilate the vessel.

In short, by muscularity, arteries are not only enabled to assist the heart in carrying on the circulation; but from the exertion of this power in certain arteries, an increased quantity of blood may be sent to a particular part, and the circulation carried on in that part with more force and activity, as in occasional increased secretions, pregnancy, or local inflammations.

By elasticity, arteries are kept at a certain diameter. In the aorta and large branches of it, this property is used to restore this diameter, when the arteries have been dilated by the impulse of blood from the heart; and in the smaller branches it is used to restore this diameter, when the vessels have contracted beyond it, by their muscular action in propelling on the blood.

From what has been stated it appears, that the contraction of the arteries does not always depend merely upon their elasticity producing re-action in consequence of the blood being thrown into their cavities by jerks, and over-distending them; for were this so, arteries could not contract beyond a certain diameter in the living body, however much their contents might be lessened, nor would they appear larger in the dead body. They could only do this, if the elastic property was always and invariably attempting to reduce their diameter, and if it did so, in the living body, the heart would be obliged to exert a much greater force than it now does to overcome this disposition to contraction; and in the dead, when the contractions and force of the heart have ceased, the elastic property having nothing to counteract this disposition, would, by contracting the diameter, make the cavities of the arteries less than in the living: the reverse of this, however, is the case.

Arteries thus form determined channels by which the blood is conducted to every part of the body. They select and deposit materials which are to be useful, directly or indirectly, in the formation and support of the body. They adapt themselves to the quantity of blood in circulation at the time. They assist the heart in carrying on the circulation, and enable it to overcome the resistance, arising from the column of blood, attraction of it to the coats of the vessels, contractions of small vessels, angles of branches, anastomoses, parts pressing on arterial trunks, and other causes. They also by contracting from their muscularity, aid the coagulation of blood in hæmorrhages which otherwise would prove fatal ; and, like the heart, they continue to act during life apparently without fatigue.

As the attraction of fluids to the sides of the vessels (if we reason from what takes place in dead matter, as in fluids moving in pipes), would render a great additional force of the heart and arteries necessary to circulate the blood through the small vessels—Mr. Charles Bell has, in a recent publication, very ingeniously suggested, that by some property depending on life, the attraction of the blood to the sides of the vessels is dispensed with; and that the motion of the blood is facilitated by the abstraction of a power, instead of by an enormous accumulation of force. In fact, that there is in the living healthy state of the body an absence of that attraction which is universal in dead matter; but that this attraction is occasionally resumed, as in the case of an opened vessel, when necessary to the safety of the individual, and that this resumption assists greatly in stopping the flow of blood.

The beating or motion in the arteries, termed the pulse, is well known to consist in the reciprocal contraction and dilatation of the heart and arteries. What depends on the heart has already been noticed.

The arteries receive their blood from the heart by distinct and separate contractions of the ventricles; in the living body they are always full, the stream of blood is always continued in them, but it appears to be increased at every contraction of the heart in strength and velocity, and if an artery is divided it never ceases to flow, although at every contraction of the heart it jets to a greater distance. As the arteries are formed of distensible materials, any portion of blood however small, if suddenly thrown into them, will not only drive the preceding wave of blood on, but will form a fresh wave increasing the diameter of the artery in proportion to the quantity ejected from the heart. When the force which threw in the additional quantity has ceased, the artery will return to its former diameter. The blood thus passing into the arteries, not in a continued stream, but by jets, accounts for the pulsation of these vessels.

By the number of beats or pulses, in a given time, we know the number of the contractions of the heart; and by particular feelings, the nature of which it is impossible to make sufficiently intelligible by description, and which can only be properly understood by having been repeatedly experienced, we can judge of particular actions both of the heart and arteries, of the comparative quantity of blood in circulation, and whether the circulation is performed with ease or difficulty.

It is not, however, by the pulse alone that we can form any certain judgment respecting the actual state of the person's health, and it may indeed much mislead us, unless we attend to other circumstances; for the pulse of some persons is naturally different from that of others. I have known the pulse to intermit every third, seventh, or tenth beat, in persons enjoying tolerable health. In one instance, where there was a regular intermission when in health, on a fever occurring the intermission ceased, and the pulse became regular. In feeling the pulse we should recollect that emotions of the mind will alter its frequency and strength. Recollections of a particular nature will often produce a temporary increase of pulsation in the patient, when the surgeon first enters his apartment. On this account a child's pulse should be felt, if possible, during sleep.

There is a considerable difference between the young and the aged, in the number of pulsations in a given time; and the number will vary even in persons at the same period of life, of the same bodily size, and enjoying apparently the same degree of health. It becomes therefore impossible to say, (a priori) what should be the natural number of pulsations in a minute in any individual.

This indeed can only be ascertained with accuracy, by attending to the person's pulse in health, after exercise, and after rest, in the morning and in the evening, during sleep and when awake; for each of these circumstances will be found to make some alteration in the number of pulsations.

It has generally been remarked that the pulse of a large man, in the natural healthy state, is less frequent by a few beats in a minute than the pulse of a little man, although of a similar age and equally healthy.

In women the number of pulsations in a minute, when in health, is greater than in men, perhaps by five or six beats.

In summer, the pulse is more frequent than in winter. In warm countries, it is more frequent than in cold. Passions of the mind are known to produce very considerable effects on the pulse; in our own persons we all must have experienced this. I have known the number of pulsations increased sixty beats in a minute, by sudden and temporary anxiety.

From some apparently very accurate observations made by the late Dr. Heberden, and which confirm those made formerly by Hoffman, Haller, and others, the pulse of a healthy infant, on the day of its birth, while asleep, is from 130 to 140 in a minute. The mean rate during the first month is 120, and it is rarely under 108; during the first year, it ranges from 108 to 120; during the second year, from 90 to 100; during the third, from 90 to 108: it varies but little from this until the 7th year, when it is from 75 to 80; at the eleventh or twelfth year, it is about 75. The principal reason, perhaps, why the pulse is more frequent in children at an early period, is, that a sufficient quantity of proper materials may be carried in quick succession to every part of their bodies for nourishment and growth.

The pulse in healthy adults may from the circumstances already mentioned, vary from 60 to 80 beats in a minute. In general, however, the pulse will be found to beat in persons under the common circumstances of life and health from 65 to 75 in a minute.

By the pulse, we not only can ascertain the number of contractions of the heart; but by it, some knowledge may be obtained of the *nature* of the contraction, of the irritability of the heart and arteries, of the quantity of blood in circulation, and of other particular circumstances, so as to enable us, in many cases, to form a proper judgment of the nature of the disease, and the danger of the patient; for in every considerable disease, the action of the heart and arteries is in some way affected. I do not mean here to treat on the alterations of the pulse that are indicative of disease: these alterations may be noticed with the diseases in which they occur, in the surgical part of the lectures; but the ready discrimination of them can only be acquired by practice. When the different states of the pulse have been felt a few times, they may be distinguished and remembered; but from description alone, unaided by practice, however accurate such description might be, no adequate ideas can be conveyed of them.

LECTURE VII.

ON THE VEINS AND THE ABSORBENTS.

I HAVE not been able to include the whole of the observations I proposed to make on the anatomy and physiology of the vascular system, in the six lectures given on the foundation of Arris and Gale, and by breaking off here, I should leave some important vessels belonging to the system unnoticed; I therefore beg permission to substitute the following lecture, on the structure and properties of the veins and absorbents, for one of the museum lectures on surgery.

The veins are thin, elastic, ramifying tubes, conveying blood from every part of the body to the heart.

Two large trunks, viz. the vena cava superior, and the vena cava inferior, leading from the body, generally terminate in the right auricle of the heart; and four veins from the lungs only, terminate in the left auricle.

A large trunk, named the vena portarum, brings blood from some of the viscera of the abdomen to the liver, and distributes it through that organ.

In the living body, veins are distinguished from arteries by the blueness of their colour, by the course of the blood, by the small knots or circumscribed swellings where their valves are formed, and by their not possessing pulsation.

In the dead body, veins are distinguished from arteries, by their cavities containing blood, by their coats being thinner and more transparent, so as to shew the purple colour of the blood through them, by their possessing less elasticity, so that when emptied they collapse, and by their having numerous valves opening towards the heart.

In veins two coats only are capable of demonstration, and even these in many veins cannot be separated from each other.

The external coat of a vein is smoother than that of an artery: it appears to be composed of fibres running in all directions, interspersed with vessels, and connected together by cellular membrane, so that no regular arrangement can be distinguished. Some of the fibres are elastic, and others muscular; but these are so completely blended, as not to admit of separation.

The elastic substance is not sufficient to preserve the cylindrical shape of the vein when divided, excepting in the popliteal vein and some branches connected with it; but is capable in every vein of restoring the vessel to its former size, after it has been moderately stretched.

In the dead body veins are of the capacity, as to diameter, in which their elastic property when at rest would retain them. However much the property of elasticity may be opposed during life, after death it has its full scope of action, as the blood contained in the veins can then afford little or no resistance to it, and muscular action ceases with life.

The muscular fibres are the most distinctly seen, and the power of muscular contraction appears to be greatest, in the superficial veins and in those of the extremities. This power adapts them to the various circumstances which require that the area of their cavities shall be within the usual or middle state, and also assists the blood in its motion towards the heart.

One proof of the veins possessing muscularity is, that during life they are often, and for a long period together, less than their medium state, or than they are found to be in the dead body. The superficial veins of the hand in cold weather are so contracted as to be scarcely visible; in warm weather they are very turgid with blood; in the one instance being much less than their elastic property makes them in the dead body, and in the other much larger. From the fibres of the external coat of veins running in all directions, these vessels are less liable to break by stretching, than the arteries.

The internal coat of a vein is perfectly smooth and dense; it has some elasticity, and if it possesses fibres, these are too small to be seen. It is smooth, to allow of the blood having a free motion along it; and dense, to prevent that fluid from transuding. This coat is continued on to join the membrane which lines the cavities of the heart.

The veins have vasa vasorum, although these are not so numerous as in the arteries. The arteriæ venarúm are ramifications of the small neighbouring arterial branches. The venæ venarum do not pour their blood immediately into the cavity of the vein to the coats of which they belong, but pass from the outside of the vessel, so as to join other neighbouring veins, and with them enter the common trunk nearer to the heart.

Many veins are surrounded with plexuses of nerves, from which they receive small ramifications; for although the coats of veins have but little sensibility in their natural state, their inflammation is always productive of pain.

That veins have absorbents, is proved by their relative proportions being preserved, and their cavities being enlarged as the animal grows.

Veins have certain interruptions in their cavities called valves; it was the knowledge of these, which afforded the principal ground work for the discovery of the circulation of the blood.

The valves of veins are thin inelastic membranes of a semilunar form: their unattached edges are turned towards the heart, being straight, and not curved like those at the beginning of the arteries. Their convex part adheres to the inside of the vein, so that each valve forms a pouch whose mouth opens towards the heart. They are generally attached in pairs, the two making two pouches, the edges of which, when the blood attempts to pass back in the vein, come in contact, and shut up the passage. These two valves are not always of an equal size. In the large veins of a horse three valves are frequently met with, but this number very rarely occurs in men.

The veins usually swell where valves are placed; from these swellings the situation of valves may be known without their cavities being exposed. Where a small vein opens into a larger, a pair of valves is generally, but not constantly, found. The valves are not merely prolongations of the internal coat of a vein, for they are not elastic.

The valves are not an essential structure in all veins, for in certain parts of the body, the functions of which are known to be of the greatest importance to life, the veins have no valves; as in the brain, heart, lungs, and viscera generally. The veins of these parts can, therefore, be filled from their trunks to great minuteness in the dead body, by throwing in injection contrary to the course of the blood.

The veins of the extremities have many valves, their minute ramifications cannot, therefore, be injected from the larger trunks. The valves are placed at different distances in different veins; sometimes many are met with in a small space, and sometimes very few in a large one.

Some anatomists have imagined that the smaller veins have no valves; but these veins occasionally enlarge, and then shew that they also possess a valvular structure.

In shape, the veins, like the arteries, are conical, if traced from a trunk to a small branch; but they are much more irregularly so, than the arteries; and if considered as to their general capacity, they are conical from the branches to the trunk.

In certain places, the area of a venous trunk shall be larger than where the trunk enters the heart, as in the neck, the area of the jugular vein is often larger in the middle, than nearer to the heart. This enlargement is not met with in the first formation of the vein, but takes place from some obstruction to the entrance of the blood into the right auricle.

It has already been noticed when on the structure of arteries, that the comparative thickness of the coats of an artery to its correspondent vein, is different in the vessels of different parts.

From some experiments made by Sir Clifton Wintringham, and repeated by others, the strength of the coats of veins, when compared with that of their correspondent arteries, is also different in the vessels of different parts; but on the whole, in the dead body the strength of the veins, although their coats are much thinner, is greater than that of the arteries.

There are two sets of veins, viz. the superficial and deepseated.

The first set are placed immediately under the skin, and are very numerous, particularly in the extremities; they do not accompany arteries, but have a peculiar course of their own.

The second set generally accompany arteries.

Both sets are met with in those parts which have strong muscular action, and then always form ready communications with each other; so that when the deep seated set are compressed by the lateral swelling of the muscles, and the circulation impeded in them, the superficial set receive the blood from them and allow it to pass on to the heart. The force of the circulation is sufficient in the arteries to prevent the course of the blood from being stopped in them, but it is not strong enough in the veins to resist the pressure of the muscles, the cutaneous veins therefore always swell during strong muscular action.

The veins, taken all together, are much more capacious than the arteries; but it does not admit of being ascertained with precision, how much larger they really are. For some parts have many and large veins with only one artery; and in other parts, the arteries and veins are equal in number; but when so, the veins are always the largest vessels. In the superior mesenteric vein, Dr. Hunter found the proportion of its cavity to that of the artery to be as five to four, which is less than the calculation of other physiologists. But as all arteries have corespondent veins, either a single one and that one larger, or, as is more generally the case, two; as there are numerous superficial veins unaccompanied by arteries, and as veins have sinuses and plexuses, it is clear that more blood must be contained in them than in the arteries, and that from this circumstance the motion of the blood in them must be slower. They also allow a greater quantity of blood to be contained in the body at all times.

There are more visible trunks of veins in the body than of arteries, particularly so in the extremities; although in other parts, the veins and arteries correspond in number very exactly. Dr. Hales, in his staticks, observes, that he has seen a number of arteries throw their blood into one vein. I have observed this also, when viewing the circulation in the microscope; it is therefore likely that there are more minute arterial than venous branches, and from the active office of arteries, and comparatively passive office of veins, it seems reasonable that it should be so.

The superficial veins are much less regular in their situation and size than the deep seated. They are never found exactly alike in any two persons.

There are certain appendages to veins called sinuses; these are chiefly situated in the dura mater covering both the brain and the spinal marrow. Their shape is triangular, and their coats are neither muscular or elastic. One set of veins pours blood into them, and another set conveys the blood from them. They seem formed for the purpose of preventing the blood which has once reached them, from pressing back, so as to produce a fullness and consequent pressure on the brain, should any temporary impediment exist to its entering the heart.

Veins have several origins; their chief origin is from arteries. It has been proved, by inspection of living animals in the microscope, and by injections of dead ones, that fluids pass from arteries to veins by a continuity of canal. In the pia mater in the human subject, injected by the arteries with tallow and vermillion, the veins will be filled by the tallow without the vermillion, and no breach of vessel, or extravasation of the injection shall be seen. The superficial veins may be filled with quicksilver from the arteries in the hand or foot, without any discontinuity of canal. The preparations in the Museum shew very clearly these circumstances.

Another origin is from cells. In the human body it is only in the corpora cavernosa penis and clitoridis, and in the maternal part of the placenta, that veins have this origin. In these parts and only in these, the veins seem to have the power of absorption.

A third origin is from sinuses, as from those of the dura mater. A fourth origin is from other veins, as in the liver, where the venæ cavæ hepaticæ arise from the extreme ramifications of the vena portarum.

The ramifications of the veins are sometimes arborescent like those of the arteries; sometimes a little convoluted, when the arteries are so, as on the heart; they are seldom or ever serpentine, as such a course would only retard the passage of the blood to the heart, without answering any useful purpose. They sometimes form arches, sometimes a net work, and in the choroid coat of the eye have a peculiar kind of ramification, which has been called vorticose.

A plexus, is a mass of veins anastomosing frequently and largely with each other. We find this structure in the corpus spongiosum penis, and in the plexus retiformis; but in these parts some other purposes are answered by this structure, not immediately connected with the circulation of the blood.

Anastomoses in veins are larger and much more frequent than in arteries, particularly in those of the extremities; this is perhaps so, because the veins are more easily compressed than the arteries; but where the arteries and the veins correspond in number, as in many of the viscera, their anastomoses are nearly the same.

It has been already stated that the superficial veins have a course of their own. The deepseated veins accompany the arteries; but are in general situated externally to the correspondent arteries, as an injury done to a vein would be productive of less dangerous consequences.

Veins have various terminations, in sinuses, as in the dura mater; in other veins, as in the liver; in excretory ducts, as in the pori biliarii of the liver, and ultimately in the auricles of the heart.

Veins like arteries, but in a still greater degree, will occasionally increase in size to answer temporary purposes, and afterwards return to their former state, as in the uterus, and breasts.

The great function of the veins is to return the blood to the heart. The two venæ cavæ return blood of a dark colour from the body generally, that it may undergo a change in the lungs necessary to its preserving the property of supporting life. The four pulmonary veins return blood of a florid colour from the lungs, after it has undergone the necessary change in that organ.

That the blood flows towards the heart in veins, may be shewn by the effect of compression made on them by ligatures; the part beyond the ligature will be full; that nearer to the heart will be empty. In the superficial veins, as in those of the hand, upon compression being removed, we can see the blood running rapidly towards the heart. Microscopical observations also shew it; and the valves opening towards the heart prove, that the blood can flow in no other direction.

The motion of the blood towards the heart is in a more uniform and less interrupted stream, than when sent from the heart into the arteries. In the larger veins no pulsation is perceptible, nor does the blood, when they are opened, flow out per saltum. The blood does not pass into the arteries in a constant current, but is thrown into them by jets or gushes. A constant uninterrupted stream passes into the veins; they have their cavities always full, and there is consequently, no pulsation in them. Pulsation in the arteries, although very strong near to the heart, is not perceptible at a distance from it in the smallest arterial branches, and therefore cannot be produced by the heart in the veins.

In the veins, two successive and alternate powers propel the blood, the heart and arteries; there is therefore, in them, a constant and uninterrupted stream, as there is of air in the double bellows.

Supposing even that in the small veins, a pulsation did exist, the trunks of the veins would have none, on account of the different lengths of the branches forming them; for the pulsation by each branch would reach the trunks at different periods, and would therefore in them become indistinct and lost. This, may be illustrated by throwing water into a sponge by jerks, when it will flow out by an equal constant stream. Or it may be proved by dividing a tube into branches of different lengths, uniting them again so that they shall form another tube, and then upon throwing in fluid at one end by a syringe at regular intervals, imitating the contraction of the heart, it will be seen to pass out at the other end in an equal uninterrupted stream. This arises from the force of the syringe being broken and divided by the different angles and different lengths of the tubes. From these causes veins can have no regular and distinct pulsation.

It sometimes, however, happens, that when a vein has been opened in the foot or hand, something like a pulsation will be perceived, and the blood will flow out with a stronger jet as the pulse beats; and in certain fevers there is sometimes the appearance of a pulse in the whole venous system. This appearance of pulsation cannot, for the reasons already given, arise from the immediate contraction of the heart; it, in all probability, arises from the lateral swelling of the small arteries immediately surrounding the veins, pressing on them during the moment of their enlargement, and diminishing their cavities.

The blood, when a vein is opened in the arm, sometimes gushes out per saltum; this happens from the immediate vicinity of the vein to a large artery allowing of motion being communicated to it from the latter vessel.

The larger veins near to the heart have sometimes an appearance of pulsation, which arises only from the contraction of the auricle preventing for an instant the free entrance of the blood. This has been seen in animals whose chests have been opened during life: in cats and rabbits, the contraction of the auricle has been seen to begin from the large veins that enter it. Even breathing produces a temporary stagnation of blood near the heart; during inspiration, the veins readily empty themselves; but in expiration, more particularly, in straining, coughing or sneezing, a certain degree of stagnation is produced.

The venous system is larger than the arterial, and therefore, independently of the force of the heart being nearly exhausted before the blood reaches the veins, the blood's motion must be slower in the veins, for though the force impelling it were to continue the same, still it must lose from its impetus and velocity, in proportion as the cavities containing it are increased in size.

It has been observed by John Hunter, "that "the blood moves more slowly in the veins than "in the arteries, that it may come into the right "auricle more slowly; for if the two venæ cavæ "were of the same size with the aorta, the blood "would have the same velocity in them, which the "auricle, as it is now constructed, could not have "borne."

The motion of the blood would be still slower in the veins, were it not, that the blood is retarded in the arteries by the resistance it meets with from the blood that is before it; whereas in the veins, it is accelerated by the impulse of the arterial stream, which is perpetually urging it on to the heart.

John Hunter thinks it may be probable, "that "the blood is assisted in its passage into the au-"ricle, by a kind of vacuum being produced, by "a decrease of the size of the ventricles in their "contraction."

The blood is farther aided in its passage to the heart, by occasional muscular contraction, and by the valvular structure of the veins.

The use of valves is to prevent the return of the blood from trunks to the lesser branches in those parts where the veins are liable to be compressed, by the swelling of muscles; and it is in situations where this is likely to happen, that we find the valves numerous. Wherever there are valves, the superficial and deep seated veins anastomose largely, so that although the blood is prevented from having a retrograde motion, a number of channels are open to it, by which it may find its way to the heart.

Valves, I have already stated, are not essentially necessary to the circulation, for they exist but partially; they are but few in the large veins nearest to the heart, and the veins of some parts are entirely without them. They therefore cannot be intended merely to insersect and support the column of blood; if they only answered these purposes, they would not be required in the jugular veins. Besides preventing retrograde motion, they may have some other latent use that is not at present even conjectured.

Before the absorbent vessels were discovered, the veins were supposed to perform the offices which we now assign to the former set of vessels; and there are some Physiologists who still attribute this action, in part, to the veins.

It did not appear likely to the comprehensive and reasoning mind of John Hunter, that nature would idly form two different sets of vessels to perform the same actions; he therefore instituted a series certainly of cruel, but still of very necessary and convincing experiments, to prove whether veins did or did not absorb.

The result established the fact, that veins did not absorb in the body generally. I state geneally, because from the corpora cavernosa penis, and from the maternal part of the placenta, where the blood is thrown into large cells, it is removed by the veins; for the process of removing it by the absorbents would be slow, and no change in it is required.

I am unwilling to excite unpleasant and distressing feelings, by reciting in detail experiments of this nature; but as the character of John Hunter stands on the surest and highest ground as an impartial experimentalist, (though I should not recommend that a fact capable of being doubted, where the resolving of the doubt would prove useful to society, should be taken on the assertion of any individual,) and as these experiments were performed in the presence of many scientific men, I flatter myself that the reciting them very concisely, may convince those, who otherwise might think it necessary to sacrifice animals in a similar way, to determine the question.

In one experiment, a living dog was opened; and the lacteals at the upper part of the intestine were seen filled with a white fluid. Ligatures were made on the superior mesenteric artery and vein; and about a foot in length of the intestine was tied up. The same was done on the lower part of the gut where the absorbents were filled with a transparent liquor; a hole was now made into each of the parts of the tied up gut, warm milk was introduced, and the vein was punctured and emptied of blood The absorbents in both parts were soon filled with milk; but not the smallest quantity entered the veins, even after the parts were returned into the cavity of the abdomen.

This experiment was repeated on the vessels without ligatures, and no milk entered the veins, although it was attempted to squeeze it into them even until the gut burst.

Another experiment was made on a sheep which had eaten nothing for some days. Starch, coloured with indigo, was thrown into the intestines, and the lacteals were filled with it; but none entered the veins, and none was found even in the serum of the blood. A pipe was placed in the mesenteric artery and milk injected into it; it returned by the veins white, and not the least blue in colour. Fluid was injected first by the artery, and then by the vein, but did not pass into the gut; nor could water from the gut be made to pass into the veins.

Experiments were also made on an ass, this being a larger animal, more patient of pain, and having a mesentery thin and without fat. Musk, dissolved in warm water, was thrown into the gut, and the fluid taken from the lacteals smelt strongly of it, while that taken with great care from the veins was entirely free from this scent.

So far as regarded the lacteals these experiments were most decided. Circumstances will not allow of equally convincing experiments to be made on the lymphatics; but from analogy we have a right to conclude that the result, could they have been made, would have been the same.

In the liver the vena portarum assumes the office, and something of the appearance of an artery. In all other parts of the body, veins are more passive than active, and serve principally to convey blood back to the heart. Some collateral purposes indeed are answered in certain parts where the veins are formed into plexuses.

Veins are subject to much more variety than the arteries, in their number, situation, and course, and do not compose so uniform and regular a system of vessels, either in their form or use.

ON THE ABSORBENT VESSELS.

The absorbent vessels are as actively employed in regulating the growth of the body, as the arteries are in forming it. They receive into the body substances from which it is to be supported and increased, and they also remove from it substances which, should they be allowed to remain, would prove injurious to it. By receiving morbid matter, hey are occasionally the means of introducing disease, and the process of removing both healthy and diseased parts of a living animal is carried on by their means.

Thus an absorbent is, a vessel possessed of the power of taking up and receiving into its cavity parts of the body itself, as well as extraneous substances within or on it, and of conveying these into the blood either for the purpose of removal, or of being appropriated generally to the nourishment, but sometimes to the destruction of the body.

It is well known to this audience, that the absorbents have been divided into the lacteals and the lymphatics. The first received their name from being often filled with the chyle, a white opaque fluid. The second received theirs from generally containing a transparent limpid fluid.

The absorbents were discovered by Asellius, who printed his account of them in the year 1627.

The lacteals and lymphatics were discovered at different periods, by different men, and a long time elapsed before they were known to belong to one system; but both sets of vessels having been found to possess the same kind of structure, and both having been traced to the same terminations, it has been unequivocally proved that they are mutually and equally employed in carrying on the important action of absorption.

In perfecting this discovery several anatomists have just claims to praise; as Pecquet, who discovered the thoracic duct in a quadruped; Veslingius, who discovered first the lacteals, then the thoracic duct in the human body; and Rudbeck, who first discovered the lymphatics, and traced them on to the thoracic duct.

The lymphatics were considered as merely appendages to the veins, which served the purpose of carrying back the watery parts of the blood, until Dr. William Hunter classed the lacteals and lymphatics into one general system of absorbent vessels. It is true that some anatomists, before Dr. Hunter, had entertained the idea that the lacteals and lymphatics might belong to one system; but they had neither proved their supposition, or brought it into general notice. Dr. Hunter proved it by incontrovertible arguments; and demonstrated it by minute injections. For many years, he spared neither time nor expence in prosecuting discoveries in this system, and induced his brother John Hunter, Mr. Hewson, and Mr. Cruikshank to assist him in the same pursuits. John Hunter discovered absorbent vessels in birds and amphibious animals, and proved, by the experiments I have recently mentioned, that veins did not absorb. Mr. Hewson discovered the absorbents in fishes. Mr. Cruikshank most zealously employed himself for many years in tracing the ramifications of this system into almost every part of the body. After Dr. Hunter's death Mr. Cruikshank published his own and Dr. Hunter's observations on this system, and with what success I need only appeal to the high reputation of the second edition of his work. To that work I shall refer those who are interested in the inquiry, for a full account of all that relates to the discovery and history of these vessels.

The thoracic duct, or trunk of the absorbent system, has, in a horse, admitted of being separated into two coats with something like distinctness. In the human body, the attempt to separate the duct into two coats has sometimes succeeded, although not so perfectly. If the thoracic duct be possessed of two coats, it may be fairly inferred, that all the absorbent vessels leading into it have a similar structure. It rarely happens that a fibrous structure can be demonstrated in these vessels; when fibres have been seen they have always been confined to the external coat, this coat is therefore supposed to be muscular. A fibrous structure certainly does not prove muscularity; for ligaments, nerves, and even the medullary substance of the brain are fibrous; but when the power of contracting upon the application of a stimulus exists in a fibrous part, it is a fair inference that such part is muscular. In a living animal, when the lacteals and thoracic duct have been exposed by opening the abdomen, these vessels have been seen to contract on their contents so as to drive them on very rapidly to the veins. The same occurrence has been observed in a recently dead animal. Both of the coats seem to possess a little elasticity. The internal coat is very smooth, thin, and dense. Thin as these coats are, I have more than once seen their arteries injected, and ramifying in a mode exactly similar to the arteriæ arteriarum and venarum. That action of inflammation, in which red lines are formed in the skin arises, most probably, first in the arteries of the coats of the absorbent vessels, then in the arteries of the contiguous cellular membrane, and afterwards in those of the skin.

The arteries of absorbent vessels must have correspondent veins. The absorbents also must have their own lymphatics, or these vessels could not increase in size, and still retain their relative proportions to the body.

It seems impossible, but that the absorbents should possess nerves, as they are certainly as active as arteries in the regulation of the growth of parts, so that nerves appear to be more necessary to them than to the veins, whose office is more passive.

The valves of the absorbents are very similar in structure, attachment, and use, to those in the veins, but are much more numerous; their loose edges are turned towards the thoracic duct. The valves are disposed in pairs exactly opposite to each other, and their situation is always marked externally by a projection of the vessel on the side nearest to the thoracic duct. Sometimes, many of these valves in one vessel are met with in the space of an inch; and sometimes the absorbent shall run for more than an inch, without being intersected by a single valve. Doctor Hunter once met with an instance in the dead body, where the valves performed their office so ill, that he inflated the lacteals from the thoracic duct; he unfortunately neglected the opportunity of filling them with quicksilver.

The origin of the lacteals is from the inner surface of the cavity of the intestines; this is proved, not only by their containing the chyle, but their orifices were actually seen by Dr. Hunter, Mr. Cruikshank, and many other anatomists and physiologists, in the intestines of a person who died soon after eating, and in whom digestion was going on at the time of death. Several of the villi of the intestines appeared perfectly white, and when viewed in the microscope, twenty or thirty orifices were seen in one villus, forming tubes which ran towards the base of the villus, and united themselves into one trunk.

The origin of the other absorbents or lymphatics is, first, from the surfaces of circumscribed cavities; we infer this from knowing that a large quantity of fluid, morbidly accumulated in such cavities, has been removed in a few hours. The arteries continually throw out a fluid to lubricate the surfaces of those cavities, and this fluid can only be regulated, removed or changed by the absorbents, their action therefore, in a state of health, must be in proportion to the action of the arteries.

Another origin is from the inner surfaces of the cells of the cellular membrane; similar grounds to the foregoing allow of this inference.

A third origin of the absorbents is from the inside of excretory ducts, such as the tubuli uriniferi, semeniferi, lactiferi, and pori biliarii, in proof of which, we know that the fluids which have passed into these ducts, when some obstruction has taken place so as to prevent them from being carried to their usual places of designation, will be removed from the cavities, and carried into the blood vessels. A fourth origin is from the surface of the air cells of the lungs, the whole external surfaces of the body, and that of all canals which have external outlets. Proofs of which are found in the absorption of water, of mercury, and of many other substances from these surfaces.

The orifices of the lymphatics have never been seen, although search has frequently been made for them among the villi of the lips, tongue, &c; but the fluid contained in them being transparent, renders it next to an impossibility that their orifices should be discovered; from analogy, however, we may conclude that they are similar to those of the lacteals, but perhaps smaller.

The course of the principal absorbent vessels is like that of the veins; the superficial running chiefly on the inside of the limbs, and the deep-seated ones accompanying the arteries. In their distribution we sometimes find the absorbents running parallel to each other, sometimes arborescent, sometimes reticular, and sometimes varicose.

The absorbents terminate first in the absorbent glands, then either in the thoracic duct, or right trunk of the absorbents, and these vessels terminate in veins.

The absorbents appear to exceed the blood vessels in number, for when only one vein accompanies an artery, we generally find two absorbents; and in parts where two veins accompany one artery, there are generally four absorbents; this is seen distinctly in the stomach of the turtle, when its absorbents are filled with quicksilver. In size they are much less than the veins, excepting the ramifications on the intestines, which are often larger.

The absorbent glands are fleshy bodies, tolerably firm in their consistence, and generally of an oval shape; but they are sometimes round, sometimes triangular, and occasionally very irregular.

They vary much in size, some not being the sixteenth part of an inch, and others exceeding an inch in diameter. They also vary in thickness, some being thin and flat, and others as thick as they are broad. They sometimes are single, but more usually they are clustered together.

In colour they are subject to much variety, their colour depending not only on the quantity of blood which they contain, but also on the colour of the fluids received into their cells. Thus the glands of the mesentery will be white during the absorption of the chyle, and in the adult those of the lungs will be blue, or even nearly black.

The surface of an absorbent gland is generally smooth. These glands have a capsule covering them, to which some thin cellular membrane is affixed which attaches them loosely to the surrounding parts, so that they may slip a little to one side, and elude any force applied to them; they are thus rendered less liable to injury from accidental pressure.

It has been doubted whether the covering of an absorbent gland was a proper capsule, or formed only from condensed cellular membrane, such as is found between the glandular part of the female breast and the pectoral muscle. It appears on the whole to be more vascular than cellular membrane, but, excepting in vascularity and density, it has no other marked difference.

Malpighi has asserted, that a muscular coat is placed under this capsule for the purpose of propelling on the fluids received into the cells; but no muscular coat is in reality found there.

The absorbent glands are well supplied with arteries; each gland generally receiving branches from the various neighbouring arteries, although sometimes a gland shall receive its blood from a single vessel. Their veins are also very numerous, and in the mesentric glands can be injected to great minuteness, as in them the veins have no valves.

The nerves of absorbent glands are so small, that some anatomists have been inclined to think they do not possess any. I have more than once traced nervous filaments into their substance.

In absorbent glands there are a number of cells much larger in diameter than the branches of any vessel entering the gland; on the sides of these cells the different vessels ramify to great minuteness. Into the cavities of these cells, many of which in general communicate with each other, the fluids and other substances conveyed to the gland by the absorbents, are for a time deposited; they are then absorbed by a new series of vessels, and either conveyed on to other glands, or to the trunks of the absorbent system. The absorbent vessels which enter the gland are called the vasa inferentia, and those which pass from it, and convey the absorbed fluids towards the thoracic duct, are called the vasa efferentia. The vasa inferentia are generally more numerous, but smaller, than the vasa inferentia of the same gland. The vasa efferentia of the first set of glands become the vasa inferentia of the second, and the absorbed fluids have thus, in general, to pass through two or more glands, before they reach the thoracic duct.

It is common for several absorbent vessels to enter the same gland. Each absorbent vessel approaching a gland, divides into several radiated branches, which spread themselves out on the surface of the gland and then sinking into its substance, deposit their contents in some of the numerous cells. From these cells, the minute branches of the vasa efferentia receive the absorbed substances, probably in the same manner that the first absorbents received them from other parts.

The ramifications of the vasa inferentia and efferentia are so numerous on the surface of a well injected gland, that the cells cannot be discovered, and therefore many anatomists have supposed that the splitting and re-union of the absorbent vessel was enough to constitute a gland. If, however, we carefully examine a gland not so minutely injected on its surface, the cells will appear very evident, also very distinct from the convolutions and ramifications of the vessels. If an absorbent gland of a horse is filled with quicksilver and dried, and then carefully slit open, the cells will be seen of a large size, and bristles may with ease be passed through the openings by which they communicate.

Where many vasa inferentia enter into one gland, the whole of the cells of that gland will not be found to communicate, and therefore the whole of them will not be filled from any single vessel. The quicksilver will sometimes be seen, during the injection of glands, to leave the gland into which it had entered, when three-fourths of the gland have not had a particle of it in their cells. Only one vas efferens has sometimes been seen to pass from a gland into which fourteen or more vasa inferentia have entered. Although an absorbent most frequently enters the gland nearest to it, it will occasionally pass by such gland, and enter one nearer the thoracic duct. An absorbent will also often split into vessels, which shall enter different glands. I have injected an absorbent on the penis, which has split into two vessels, one going to each groin.

The whole of the vessels, nerves, and cells, which form a gland, are connected to each other by cellular membrane, in the cells of which a peculiar fluid is occasionally found, called by Haller, succus proprius glandularum. It is principally in young animals that this fluid is met with; it diminishes in quantity as the animal grows older, and is not to be found in the glands of the aged. It is generally of a white colour; sometimes inclining to red, sometimes blue, and occasionally it has been found almost black. When viewed in the microscope this fluid appears to have globules very similar to those found in milk. It is most probably secreted by the arteries, as it is totally different from the absorbed fluid passing through the cells of the gland. It is found in every lymphatic gland, but its use is not known. Mr. Hewson supposed that the globules found in it, afterwards became the red particles of the blood.

The absorbent glands in old age diminish so much in size, that it has been asserted by some, that they disappear entirely in people who are much advanced in life. The glands certainly in old people become less; but at the most advanced period of life, the absorbent glands will be found, on being carefully searched for. The vascularity of the body after a time diminishes; the vessels whose office it is to introduce supplies into the system suffer this diminution, perhaps, in a greater degree than the arteries, so that from this cause alone, independent of any actual disease, death must eventually take place.

The fluids usually absorbed are the lymph and the chyle. I shall here only notice the general properties of the lymph. It is the fluid which is absorbed from the circumscribed cavities, and from all internal surfaces whatever which have no external outlet. It resembles water in fluidity; it is generally transparent, but sometimes it is of a straw colour, or even of a light brown; when the lymph is extravasated from its vessels it either coagulates wholly or in part, as the animal to which it belonged is stronger or weaker; it has no taste or smell; and does not soon putrify. In all probability the lymph is therefore something more than the fluid absorbed from surfaces upon which the arteries had deposited it to lubricate them; for such fluid does not coagulate in a heat less than 160°, whereas the lymph coagulates upon exposure only, and in so doing it greatly resembles the coagulable lymph of the blood.

The absorbent vessels act both upon solids and fluids. Even bone itself is readily removed by them; of this instances are constantly occurring in the growth of bone, in the removal of the alveolar processes after the teeth have been extracted, in exfoliation of bone, and in the decrease of the weight of bone in old age.

I shall not here discuss the question, whether they can absorb the particles which they remove in a solid form or not. We have a proof in the absorption of calomel from the surface of the body, that they can receive solid particles; but as all the solid parts of our bodies were formed from a fluid, viz. the blood, it appears more probable that some change takes place in the particles to be absorbed, converting them again to fluid; but the actual fact is not made out.

The absorbents are not equally active at all times, for although the whole of the villi of the intestines may be immersed in chyle, very few of them will be found at any one time filled with it.

It is not an easy matter to account for the absorbents taking up even fluids. It has been supposed that fluids entered them upon the principle of capillary attraction, and it is not capable of demonstration that this may not, in part, be the case; but there are strong objections to this opinion; if the end of an empty capillary tube is immersed in water, that fluid must enter and continue to rise in the tube if it meets with no obstruction. But the orifices of the lacteals do not always attract fluid when immersed in it; they also act more at one time than at another; there is likewise something in the action of the absorbing orifices which resembles selection; for example, they receive the chyle and reject the bile, although both are fluid. The vessels also are irritable and capable of being excited by stimuli.

Boerhaave has a confused theory, formed upon the thoracic duct being divided into so many void interstices as it has intercepting valves, into these, he says, the chyle will flow, and pass on from the first to another which has just contracted and driven on its contents, and so on successively, on the same principle that air flows into a vacuum: and this has been applied by some physiologists to the first branches. This, however, cannot be the case, as no membrane in the body can form a vacuum by emptiness, for the weight of the atmosphere would press its sides together. Even should a vacuum be formed, this theory would not account for the variety in their action; the absorbents should, when immersed in any fluid, receive it, and convey it to the blood; the only variety in their action which could take place, would be from the difference of the pressure of the atmosphere, but this is not so. The vis a tergo from blood vessels cannot force fluid into the absorbing orifices, nor can it propel on to the thoracic duct the fluid actually received into the absorbent vessels, as these vessels have no immediate communication with the arteries, but arise from surfaces. It has also been proved from John Hunter's experiments, that they will receive and convey fluids to the absorbent glands from the cavity of the intestines, after the mesentery has been exposed, and ligatures made on the trunks of the vessels belonging to it.

Absorbent vessels possess great irritability; it has been already stated, that they have been seen on exposure to contract and drive on their contents rapidly. They have done the same when a stimulus has been applied to them.

It has been supposed by some nosologists that the absorbents may occasionally have a retrograde action; but from the number of valves which they possess, this does not appear to be possible; nor do I know of any sufficient evidence of such retrograde action ever having taken place in the absorbents of an animal body.

Various uses have been ascribed to the absorbent glands; our knowledge however of physiology is not sufficiently advanced to throw any light on this subject.

The opinion entertained by Morgagni of each gland being furnished with a muscular coat, for the purpose of driving on the absorbed fluids, is not borne out by the actual structure; nor do the absorbent glands appear to be either muscular or irritable. The supposition of Nuck, that their use was to afford a fluid to dilute the lymph, has no support from the known qualities of the succus proprius glandularum, as this fluid is not thinner than the lymph.

The absorbent glands are certainly very vascular from arteries; and in some animals, as in the horse, the inner lining of the cells, from this vascularity, puts on the usual appearance of a secreting membrane; but whether it does actually secrete, or what it secretes, we have no means of thoroughly knowing. Other opinions, such as their straining the lymph or chyle; forming the central particle in the globule of blood; making up the loss occasioned by the secretion of the conglomerated glands, &c. are to be regarded as suppositions, without even a shadow of proof.

As the absorbent glands are often affected by diseases which occur in distant parts of the body, our knowledge of their particular situation, and the origin and course of their vasa inferentia, must often prove of essential service in enabling us to discriminate the nature of the disease, a-though we are unacquainted with their immediate use.

All the purposes which absorption answers cannot be dwelt on here; but the principal are, the nourishing of the body, by taking into it the proper quantity of those materials which are to supply its waste, or to increase its size; the modelling the growth of the body, as no part could increase in size and preserve its relative proportions, unless particles were removed from some surfaces, while new matter was deposited on others; the regulating the quantity of moisture in circumscribed cavities, by removing as the arteries deposit, and thus preventing an undue accumulation; the resolving of tumours and other adventitious depositions of solid or fluid matter; the separating dead parts from living; the conducting dead detached parts or extraneous substances to the surface, for the purpose of removing them from the body; in fact, the constant changing all the particles of our bodies; and so perpetual is their action in doing this, that it has been supposed by very able physiologists, that no particle which entered into the formation of our bodies seven years ago, can now be found in them.

Absorption is often the means of introducing morbid matter into the system; but it is also the means of administering remedies. When the action of absorption is indolent, we are in possession of various modes of increasing it; and although we know of no certain means of directly diminishing it, we may weaken its powers by avoiding stimuli.

LECTURE VIII.

OBSERVATIONS INTRODUCTORY TO THE MUSEUM LECTURES UPON SURGERY.

FROM the commencement of my professional education, I have felt how greatly the science of Surgery has been indebted to John Hunter, for the establishment of principles, in the treatment of diseases, founded on the knowledge of the natural structure and healthy actions of our bodies; but strongly indeed have I felt my personal obligation to him, since I have had the honour of addressing you as one of your Professors of Anatomy and Surgery; for, without necessarily obtruding my own ideas, I can fulfil the duties of my situation, by submitting to your consideration, some of the results drawn from experiments and observation, when formed into principles by his laborious and scientific mind, and by exhibiting to your inspection, preparations made by him, for the confirmation and dissemination of knowledge built upon the basis of reason and of truth.

I do not pretend to give you an arranged history of John Hunter's opinions. Mr. Abernethy ha already made us familiar with his views and doctrines in those valuable lectures which he delivered in this place, and which he has since published; but as much of the matter which I shall offer for your consideration, has been either directly or indirectly founded on John Hunter's opinions, if it has any merit, to him let it be attributed. I do not mean to particularize every idea I have imbibed from his labours, if I did so, I should be for ever naming him; but I shall use his arguments, experiments and preparations, as illustrative of doctrines originating with him, although now incorporated with surgical science; and in doing this, I shall feel it my duty not to neglect those of other persons, which can be usefully employed, even should they prove to be in direct opposition to John Hunter's.

Few circumstances have more effect in the retardation of the improvement of Surgery, than the disposition to adopt the opinions and practice of some celebrated men, rather than to appeal to nature in matters of fact, and to use our own judgment in matters which depend upon the exercise of the understanding. The natural, as well as the acquired powers of men are in very different degrees, so that the generality of mankind must always be led by the invention and talents of a few; but we not only do injustice to the understanding which we possess, and fail to contribute our proper share to the general stock of professional knowledge, but become also the means of propagating error, when by an implicit reliance on the doctrines of others, we adopt opinions which we might have known to be erroneous, had we bestowed proper reflection on them. On the contrary, by weighing every opinion, and considering the principles and effects of every mode of practice, we add our quota to the general stock of funded knowledge, and are confirmed in our dependance on those opinions which will stand best the test of such examination.

From the exertions of John Hunter, aided by those of other individuals in this country, and by those of the Members of the Royal Academy of Surgery in Paris, Surgery has long ceased to be considered merely as the mechanic art of using the hands or outward applications to cure external diseases. It comprehends the science of investigating the principles of disease generally; and is more particularly devoted to the acquirement of the knowledge of the causes, effects, and mode of cure of those accidents or diseases which are attended with an altered state of the form of the body, and where the use of the hands, of instruments, of other external applications, or internal remedies can relieve, or cure such alteration.

Advantage having been taken of the derivation of Surgery from two Greek words, it was formerly considered merely as a mechanic art, and left to be practised by men without literature, and without any knowledge of the structure of an animal body; the Priests or Physicians undertaking to determine in what cases operations should be had recourse to, and to give instructions how they should be performed. It has even been asserted, that the art of performing surgical operations would be more quickly brought to perfection, were it confined to those who had no other pursuits to draw off their attention. A small degree of reflection must convince us, that this assertion is not well founded, and that the art of operating could not have been brought to its present state of perfection, but by men who were equally conversant in theory as in practice. Practice undoubtedly will give dexterity to the hand; but it will not give to the head that judgment and knowledge, which should regulate and direct the hand.

The art of operating, abstractedly considered, depends on a knowledge of anatomy, good eyes, and dextrous hands; with these a man of very moderate mental powers, if nothing uncommon should occur, may perform the operations usually required in general practice, safely and well. But if a person of this description is prevented from using his understanding in informing himself of the nature, causes and effects of the disease, he is degraded to a mere machine; he will feel perfectly contented if he can perform an operation dextrously according to prescribed rules, as he is deprived of every inducement or encouragement either to remedy the deficiences of the present, or to seek for a better mode. A person who has never performed an operation himself, is not very likely to improve those commonly practised, much less is he likely to invent new ones which might be better: thus all the advantage from such arrangement, would be dexterity in performing those operations at the time in use, while it would effectually prevent the progress of improvement; had it been generally adopted from the time of the Greeks, in all probability, we still should have been using a hot iron to stop the bleeding arising from the division of arteries, instead of the more safe and gentle means of the ligature.

From the apparent accuracy of the rules to be met with in books, the performance of operations appears to be rendered so easy, that practice only seems to be required to perform them safely; but every experienced surgeon must have found, that circumstances have occurred, at times, even in the most common operations, which he had not foreseen, and where prescribed methods could be of no use to him. The cases of injuries done to the brain, for example, which require the removal of some part of the bones of the cranium, are so various, that it becomes absolutely impossible for any rules of practice to comprehend the whole of them; the operation must consequently depend upon the particular circumstances of the case. From the immense varieties in shape, size, and situation of tumors requiring extirpation, and which may be surrounded by large blood vessels, and important nerves, experience in one case, can be of little use in another: and something more than dexterity is required; the operation must here vary according to the exigencies of the case, and the patient's life must depend on the judgment, knowledge, and reflection of the operator. It cannot for a moment be seriously supposed, that a man, whose hand is to be guided by the head of another, can either improve his art, or will be able, even in the presence of, and under the immediate direction of his guide, to perform any unusual operation, without the greatest risk of injuring or even destroying his patient. A very ingenious French writer has observed, that with equal propriety, we might contend for the division of the science of mathematics into two parts, because instruments must be used to trace on paper the figures and demonstrations which the mind suggests; and surely we should have no very high opinion either of a mathematician who was totally unskilled in the art of using his instruments, or of one who could only use them in drawing figures suggested and explained to him by the science of another. They greatly detract from the true value of surgery who would thus confine it. In addition to what I have remarked, let me call to your recollection, the very great improvements which surgery has received, and the respectability it has acquired, since it has been practised by men of literature, in whom the theoretical and practical parts have been combined.

It must, however, be owned, that the conduct of some surgeons has afforded grounds of support to those who have contended for the utility and propriety of this division. Nothing imposes more on the mind than the acquirement of popularity. The performance of any great or uncommon surgical operation, makes a stronger impression on mankind from the feelings it excites, consequently, is more talked of, and wondered at, than the most unexpected cures, unaccompanied by an operation, but effected entirely by the persevering attention and skill of the surgeon. Led away by the astonishment and eclat which the success of such an operation occasions when dexterously and quickly performed, some surgeons have thought that the art of operating was the most essential part of their profession, and have devoted the whole of their attention to it; forgetting that the operation, however perfectly performed, is only one point gained in curing the patient; that the complete knowledge of the case, the accidents which may happen, and the treatment which must be varied according to these accidents, are all equally essential. Let us suppose ourselves for a moment in the situation of a patient with a diseased extremity, and we shall soon form a proper estimate of the comparative merit of two surgeons, one of whom, by care and attention, proposes to cure the disease and save the extremity; the other, only proposing to deprive us of it in the neatest manner possible. It was a remark of John Hunter, who at that period was one of the most skilful operators of the age, "that a surgeon should never approach the victim to an operation, but with great humility, and considering it as a disgrace to the art, that we could not cure the disease without having recourse to one."

Other surgeons have encouraged this division from mere idleness, conscious that a dexterous hand may be procured with much less trouble than an understanding head, and hoping that the one may be used as a cloak to conceal the want of the other. Thus, vanity in one instance, and idleness in another, have greatly contributed to lessen the real importance of surgery, by attracting the attention of the surgeon to one point, and this to the neglect of others, which, though less splendid, are more useful.

An almost exclusive attention to operations is witnessed in the conduct of some students while attending the hospitals, and marked by the avidity with which they crowd to see them performed, when possibly they may not have enquired into the previous treatment of the diseases, and remain unacquainted with the particular circumstances which rendered the operations advisable.

Let it not, however, be inferred from the above observations, that I wish, in the smallest degree, to lessen the necessary attention which every surgeon should pay to the operative part of his profession. No operation, however trifling, and unattended with danger, can be performed without some pain, and a certain degree of dread on the part of the patient; and cases do frequently occur, where very painful and dangerous operations must be performed to preserve life, or to prevent existence being dragged on in misery for years. Every thing which can lessen the suffering and encourage the mind of the patient, should carefully be attended to. It is therefore the indispensable duty of the Surgeon to take every opportunity of perfecting himself in this, which is so marked a part of his profession. The pain which must be saved to a patient by performing an operation as tenderly, and in as little time, as is consistent with performing it safely and well, must be an inducement to this in a man of humanity, and add greatly to the satisfaction he must receive in knowing, that he is not by ignorance, or inattention sporting with the feelings, or life of the sufferer. I only wish to caution against the celebrity which attends a high degree of excellence in this part of our profession, taking so strong a hold of the mind, as to prevent it from paying sufficient attention to the less splendid, but more substantial parts.

As Surgery then consists in something more than the knowledge of external applications or performance of operations, as it consists in the knowledge of the principles of disease, and as the principles of external and internal diseases are exactly similar, each of them having the same causes, indications, and frequently the same terminations, it is obvious, that the knowledge which will enable a man to practise physic with success, is equally necessary to form a good Surgeon. From the difference in situation, we are enabled to try modes of cure in external diseases, which we are prevented from doing in internal. In the one, the disease is perceptible to the sight, consequently its extent and nature is easier to be ascertained, and sometimes when judge dnecessary; it is capable of being extirpated; in the other, it can be known only by its symptoms, and treated only by the exhibition of medicines: the difference in practice arises entirely from the difference of situation; but the knowledge of the principles of the disease is equally necessary in both.

The connection between external and internal diseases is indeed so inseparable, that there is no part of the knowledge of a Physician, which would not prove useful to a Surgeon, and every Physician must find himself materially benefitted by an extensive knowledge of the theory and practice of Surgery.

This connection renders it almost impossible to ascertain exactly the boundaries of the two professions, for cases do occur which appear to belong equally to the one as to the other. Celsus was aware of this, for he says, "Omnes medicinæ partes ita "connexæ sunt, ut ex toto separari non possunt." As I do not mean to attempt to settle these boundaries, I shall dismiss the subject by observing, that the established custom of this country requires, the regular members of each profession should interfere no more with each other, than they are obliged to do from unavoidable circumstances.

Within the last century, from a combination of various causes, the operative part of Surgery has been so much improved, that little more in this branch can be expected. It is chiefly to the increased knowledge of the principles of disease, that we are to look for future improvements in Surgery. The accumulated and united observations of many ages have thrown much light on this branch of our profession, but it is still far from being perfect, and notwithstanding the aids it has recently received from the splendid abilities of some of its professors, the variety and number of diseases, the causes of which are still unknown, and for which no certain modes of cure have been discovered, afford a vast field for the exercise of our talents and industry.

The reason why this part of Surgery has made so slow a progress in comparison to the operative branch, is partly owing to the intricacy and difficulty of the subject, and partly to some peculiar disadvantages which attend the prosecution of our enquiries in it.

In almost every other science, more particularly in the two other learned professions, there are certain maxims and laws forming an established standard, to which every doubt and difficulty may be referred, and by which they must be determined. Application, assisted by a good memory, may enable us to obtain a competent knowledge of this established authority; bounds are by it fixed to the understanding, and there is neither room or encouragement for the exercise of our ingenuity beyond them, as this authority, whether right or wrong, must be submitted to. In enquiring into the principles of disease, the case is materially different; there is no boundary set to our knowledge, nor any authority sufficiently established to refer to, in doubtful or difficult cases; every man must rely upon his own judgment and experience, unless he means to follow the opinions of some particular men, regarding these opinions as oracles.

The rudiments of most of the arts and sciences having taken place before the use of letters was known, consequently before there were any certain means of recording how, or when they began, their immediate origin must always remain involved in uncertainty and obscurity, as the knowledge of it could only be conveyed to us by memory and oral tradition.

The wants and necessities of mankind would soon impel them to enquire into the means of procuring relief; would therefore instruct them and render them industrious. Those arts which were necessary to the preservation of life, or to render existence comfortable, would begin first, and as they improved, they would introduce others which were more connected with the elegancies and luxuries, than with the necessities and comforts of life.

The human body is composed of materials liable in themselves to decay, capable of being deranged and destroyed both from external and internal causes, and at all times must have been exposed to injuries from falls, bites of wild beasts, and many other accidents; relief of course would be sought after, and thus it is evident, that Surgery must have commenced at a very early period; indeed that the first man must have been the first Surgeon.

It is also probable, that Surgery was the first branch of the healing profession which was practised. It is reasonable to suppose, that from the uniformity and simplicity of the manner of living in the primitive ages, particularly so far as regarded diet and exercise, those diseases which require physical aid, were much less frequent than we now find them; and that the causes of internal diseases not being evident, would induce those people among whom they first took place, to consider them as the immediate judgment of the Gods. Indeed, we find this idea to have been so strongly impressed on their minds, that it was held impious to endeavour to obtain relief by any other means than by appeasing the supposed offended deities; and the Priests availing themselves of this impression, which so greatly tended to increase their influence and profit, engrossed the whole of the practice of physic to themselves. Even in present times, we find that this is so among most of the barbarous nations in America, and in several of the lately discovered islands. Accidents must at all times have occurred, indeed, they were likely to happen more frequently in a rude, than in a civilized state, and their causes being obvious to every observer, and incapable of being involved in mystery by any particular set of men, left this part of the profession more open to general practice; and consequently, more open to improvement.

The practice of Surgery at first would be much confined, as it could only be used in those cases, where the causes, effects, and methods of cure were tolerably obvious, as in the case of a man breaking his arm. Immediately after a fall, or after having received a blow on his arm, he would perceive that he was incapable of moving it, that the attempt to do so produced much pain, and probably he would then feel the broken extremities of the bone grate against each other; he would also find that when it was kept at rest, and placed in a certain position, it would become comparatively easy; he would naturally endeavour to keep it in that position by bandages or other means, this he would do only to procure ease, without knowing or even enquiring whether the bone would unite or not: after some time, on his again attempting to move the arm, he would find the pain and grating gone, and that he could use his arm as before. Thus it is probable every man at first had some pretentions to skill in Surgery, either from having met with some accidents in his own person, or from having seen them terminate favourably in others.

In process of time, those men who had seen the greatest variety of cases would be applied to in preference to those who had seen less, and from the opportunities thus given to them would observe one mode of treatment more frequently to succeed than another, and would begin to enquire why it did so. The facts would strike them first, they would then begin to investigate their causes. From the combined motives of interest and humanity, they would communicate their observations to their children and friends, and every day adding fresh experience to the stock already known, the art would improve; but would become confined to those who had given up the whole of their attention to it. Thus Surgery although it might have arisen from necessity, or a simple imitation of nature, could only be perfected by the accumulated observation, and reflection, of ages. Had every Surgeon, from avarice, from jealousy, vanity, or any other such unworthy motive, carried all the knowledge which he derived from personal experience with him to the grave, the art would at this moment have been in its infancy. Any concealment in a useful science, must be detrimental to the interests of society; but in one which has for its principal object, the preservation of mankind, concealment becomes a crime.

In Surgery however, there have been many practitioners, who disclaiming all self-interested motives, have candidly communicated not only the means by which they have succeeded in relieving or curing diseases; but what is of equal consequence to the improvement of their art, they have, with a generous confidence in the good opinion of mankind, unreservedly acknowledged their errors, and thus made their failures useful, by cautioning posterity to avoid them.

In commencing the Museum Lectures upon Surgery, I shall introduce them, by some observations upon disease generally.

When an alteration in the organization of the component parts of the body, takes place, so as to produce any obstruction to, or deviation from the natural actions or functions, either generally or partially, or to occasion the performance of these actions in any part to be attended with pain, disease is then said to exist in such body.

Disease also exists when there is a deviation from a healthy action, where no altered structure can be found.

Every part of the body is capable of taking on some other besides the natural healthy actions, and some parts are capable of taking on a greater variety than others; none however but the natural actions do take place, unless some particular impression is made to produce them.

In this there is a great similarity between the body and the mind. All men are susceptible of different passions, as fear, anger, love, or hatred; and some men are more susceptible of one of these than of the others; but neither of these passions will take place in any man, unless some impression is made to produce it. Thus the susceptibility of being acted on may exist both in body and mind, without any particular action or passion necessarily taking place, the impression which would have produced it never having been applied. A man, therefore, may live without any active disease until he is destroyed by old age.

As the human body is liable to be acted on by a great variety of impressions, so also is it liable to go into a great variety of actions; but all which do take place either generally, or in any part of it, excepting the natural actions, must be diseased actions; or actions which take place to free the constitution, or part, from disease; for example, in consequence of some irritation, an action takes place in a part of the body, which action, should it go on, would ultimately destroy the part. This is truly a diseased action; but another action may also arise in the part, which has a tendency to restore it; this is different from the natural action of the part, and although it is not itself a diseased action, it takes place only in consequence of disease.

Diseased actions depend on the nature of the impressions; the parts on which they are made, and on the constitution of the patient. Thus the actions may be more various than the impressions: one kind of impression may produce a fever; another, an inflammation; another, scurvy; and another, a broken bone. The same impression applied to two or more different parts of the same body, may produce two or more different actions; as cold applied to the extremities, producing chilblains, or gangrene; applied to the head, producing catarrh; to the chest, cough, or pleurisy. Some constitutions, though enjoying the same natural health, are more susceptible of some one particular diseased action than of others; thus, in two different constitutions, as in two different parts, the same kind of application may produce two different diseases, in one, a fit of intemperance may bring on the gout: in another, it may produce fever. As the constitution of a man is frequently altered, it therefore follows, that similar impressions made at different times will not always produce similar effects.

There are also in certain cases, some varieties in the actions themselves, which depend upon a peculiar quality of the impression or external application. Inflammation may arise from any irritation applied to the body; besides arising from all common irritating substances, it will arise from the matter of those diseases termed specific, as from lues, small-pox, scrofula, and cancer. The inflammation, however, produced by any one of these, will be different in its effects from that produced by any of the others; and each of them will have different effects from common inflammation. Inflammation, as a general action, is produced by common and specific irritations; but every specific application will make some alteration in the mode of action, although it does not change it entirely.

It appears that two diseased actions rarely produce their effects on the constitution at one and the same time; nor do they exist long in one and the same part: for the greater will either suspend, or destroy the less; or when the constitution is more susceptible of one diseased action than of another, although the impression producing this action happens to be applied last, and in some cases, even after another diseased action has begun, it will take place, and either hinder, suspend, or destroy the other. John Hunter has related cases of this kind, where the small-pox was suspended on the appearance of the measles, and when the measles, having gone through their regular course, had disappeared, the small-pox then went regularly through their course. Mr. Cruikshank met with cases similar to these, and John Hunter has quoted them. I have seen the occurrence four or five times, the period of the stoppage and suspension varying. Although this is generally the case, there are exceptions to it. Dr. Patrick Russell has published two cases in the second volume of the Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge, in which, when the measles and small-pox were epidemical at

Aleppo, in 1765, the two diseases existed and went through their courses together. In three hundred cases, the reciprocal influence of the two diseases was carefully attended to, and many of the children suffered both diseases in succession as usual.

Other diseases besides the measles have suspended the operation of the small-pox. Sir James M'Grigor, who did me the honour to attend the course of Lectures on Surgery, which I gave in 1794, and in which I had quoted the instances above alluded to, from John Hunter and Mr. Cruikshank; in the following year, he having then become Surgeon to the 88th regiment, favoured me with an account of several cases confirming what had been stated on this subject. When that regiment was in Jersey, an infectious fever was prevalent; it was also necessary, the regiment being newly raised, to inoculate the men for the small-pox; all who had previously received the infection of the fever, did not take the small-pox until the fever had gone off, and many were obliged to be inoculated twice.

In local disease, we often find, that when two take place in the same patient, one only shall go on; the other shall soon subside, thus when a large abscess takes place in one part of the body, a lesser one, though of much longer standing, and which before shewed no disposition to heal, shall suddenly get well. Issues healing old sores may be adduced in proof of this; as may the following case, the whole of which came more immediately under my observation than cases in general can do. A person aged eighteen, had an abscess in his lungs, from which he expectorated more than a pint of matter daily for months; a swelling at length took place in his left arm, a little above the wrist, the inflammation continued very violent for some days, and a very large abscess was formed; which was opened by Mr. Cruikshank. From the time the inflammation in the arm became violent, the expectoration from the lungs, and the cough attending it, became less, and continued diminishing as the abscess in the arm increased. The matter in the arm had affected the radius, so that an exfoliation took place from that bone; this necessarily prevented the abscess from healing, and gave an opportunity for observing, that when much pus was discharged from the arm, a small quantity was discharged from the lungs, and when but little pus was discharged from the arm, the expectoration and other pulmonary symptoms were increased. At last the abscess in the lungs became perfectly closed, as did that in the arm after the exfoliation had taken place.

It is not an unfrequent occurrence for an affection of the constitution to produce an alteration in the appearance of a local disease; as a fever attacking a patient, and putting a stop to the healing of an ulcer. From the above recited facts we may infer, that nature in some constitutions can only manage properly one, beyond its usual actions, at the same time. This seems confirmed by what happens occasionally in women who fracture a bone during pregnancy, viz. that there is no disposition to form callus until parturition has taken place. But we are not without proofs, that the constitution of some people is equal to two additional actions; two abscesses in the same person, occasionally remain open for a considerable time, shall at last heal together; and callus sometimes forms during pregnancy.

Daily experience convinces us, that extensive sores, and even those of a specific nature, may be formed and remain in different parts of the same patient at the same time, as a scrofulous sore in one part, and a venereal one in another. A local affection of a specific nature takes place, while the constitution is affected with another specific disease; a chancre has been known to appear during the eruption of the small pox; and the presence of a chancre does not prevent the small-pox from taking place. A man having a chancre is inoculated, the variolous matter when absorbed, has the power of affecting the constitution in a week; the venereal matter, in most instances, and requires six weeks or more to do this;

the fever and the eruption of the small-pox therefore take place, while the other remains only a local disease; one affects the constitution, while the other is confined to a small part of the body. It therefore does not follow, that a person cannot have two diseases at one time, viz. a local and a constitutional one, or two local diseases; it appears, however that the constitution generally, is rarely affected with two diseases, going through their usual progress together; but that the one, of which it is the least susceptible or the weakest, will be prevented by the strongest from appearing or going on, until it has produced its effects; thus two fevers very rarely exist at the same time, which are to terminate in two different eruptions. It does not appear, that two different specific actions can go on at the same time in the same part; that is, the same sore cannot be both variolous and venereal, the action of which it is most susceptible, will suspend or destroy the other; few people would submit to a decisive experiment to prove this, but they never have been seen combined. Although the small pox has appeared when there have been venereal spots on the skin, a pustule, I believe, has never been seen to take place on a part previously occupied by a copper spot.

Another general remark which I wish to make on disease is, that some diseased actions, produce their effects on certain parts of the body, but cannot produce them on others; thus variolous matter produces its effects on the skin; the venereal affects the skin, the throat, and the bones, but perhaps never any of the vital parts. Other diseases take place in every part but with some the difference in their effects, from the variety of structure met with in an animal body, as that of muscles, bone, cartilage, tendon, ligaments, and viscera. Thus scrofula and cancer, although they are generally at first confined to glands and secreting surfaces, may in time proceed to affect every part of the body. It may here be observed, that the smaller the powers of life are, which any part possesses, the farther disease, when it once has taken place, may be carried in it, and the more difficulty will attend the cure.

The different periods of life make a considerable difference in the susceptibility of being acted upon by the same impressions: thus an infant is more disposed to have certain diseases than adults or the aged, as hooping cough, worms, bowel complaints, hydrocephalus, and also scrofula, which attacks adults more rarely, although it often re-occurs in the decline of life. Some fevers appear to be nearly confined to the adult, as do many nervous disorders. The aged are liable to many diseases almost peculiar to this period; such as spontaneous mortifications, loss of the senses, and ossifications, and are much more liable to others than adults are, as to gout, scrofula, and cancer.

Diseased actions are also much influenced by climate, for different climates not only have diseases peculiar to themselves, but the same disease is much altered by them. In hot climates, for example, diseases of the liver are very frequent, and so are putrid fevers. In these climates, upon the whole, there appears to be a greater disposition to putrescency; the voluntary actions seem to be diminished, a greater indolence is produced in them; and in nearly the same degree, the involuntary actions appear to be increased; this must tend to wear out the powers of life.

It may however be remarked here, that some diseases are cured sooner in summer than in winter, and in warm countries, than in cold. Incurvations of the spine are of this class; so are strictures of the urethra; and scrofula is a disease much more rarely met with in warm than in temperate climates.

Cold climates have also their peculiar advantages and disadvantages; upon the whole, there is much less variety in their diseases; and the powers of voluntary action appear to be greater in them; there is much less disposition to putrefaction, so that simple life, or a power of self preservation, continues much longer in them, than in warm countries. Many diseases are however more obstinate in cure, and they have some diseases which are not to be met with in the warmer climates.

In temperate climates, there is the greatest variety of diseases, though their most dangerous symptoms are not in general carried so far as in the two others. In a climate like this, which is constantly varying, the diseases of both hot and cold countries occur; but their most violent symptoms are usually much lessened. Scrofula, colds, consumptions, and agues, are the peculiar diseases of those climates.

Symptoms are some effects of a disease of the body, which are referrible either to the mind or senses of the patient, or the senses of others.

Some symptoms can only be referred to the patient, such as pain, and the loss or diminished function of some of the organs of sense, as hearing, taste, or smelling. Thirst, anxiety, restlessness, weariness, are also of this class. But diseases often produce effects equally evident to the senses of the patient and of others; thus the alterations in the pulse, and the appearance of the eyes, skin and tongue, are obvious to all observers.

When the same disease, and in nearly the same form, affects different parts of the body, many of its symptoms are different, as many of them depend upon the situation, structure, and actions of the part affected; thus almost every part has some symptoms peculiar to itself.

Symptoms, like diseases, are both local and universal, and the same disease often has both, so that it becomes very difficult, sometimes perfectly impossible to distinguish between them and the original disease; indeed symptoms are often diseases and symptoms at the same time; thus venereal blotches, and nodes, are in themselves diseases, as in them there is an evident alteration of structure; yet they are to be considered as symptoms of the venereal disease having affected the constitution. In this disease, speaking of it generally, the morbid alteration consists in the venereal virus having been introduced into the body.

Besides those symptoms, which take place and affect the whole body in consequence of the disease of a particular part, as symptomatic and hectic fevers, which by some have been called general sympathies, there are also symptoms which take place in particular parts, in consequence of a disease having affected another part, when we are perfectly ignorant of any connection between them. These are generally known by the name of partial sympathies, as pain in the shoulder, accompanying an inflammation of the liver; an abscess in the joint of the hip, being accompanied by a very considerable pain in the knee; but in neither of these cases is the sympathy reversed; that is, a disease in the shoulder is not accompanied by a pain in the liver, nor is an abscess in the knee, by a pain in the hip joint.

In other instances, partial sympathies are capable of being reversed; for example when the stomach is affected, it often produces a violent pain in the head, as in sickness from improper food, or indigestion, and in violent injuries of the head, such as produce compression of the brain, the stomach is almost always affected, to that degree that nausea and vomiting take place. The stomach also often sympathises with the skin, and the skin with the stomach. Eruptions of the skin are frequently attended with sickness; and some fish, as salmon, eels, and lobsters, will produce when taken into the stomach in certain constitutions, an erysipelatous eruption on the skin of the face, neck and breast.

In universal diseases or sympathies, the whole of the healthy actions undergoes some alteration. The action of the heart and arteries is altered; so is respiration, both in the number of respirations in a given time, and in the mode of carrying it on. The secretions are altered, and often so in a considerable degree, those of the mouth in particular, so that the appearance of the tongue, frequently enables us to form some judgment of the nature of the disease, from its being dry or moist, and from the colour of the mucus which is secreted on its surface; a crust of white mucus is generally considered as denoting strong action of the vessels, and as this mucus is more or less brown, it is supposed to indicate the degree of disposition towards putrefaction. The secretion of urine is also often altered, so that from it, we may be assisted in judging of the disease. Indeed in all constitutional diseases when violent, absorption, nutrition, muscular motion, even animal heat, and the mental powers will be in some way affected.

Symptoms and diseases are thus very complicated, and may become much blended together, for there may be symptoms of symptoms. It therefore will require, in many instances, much judgment and attention, to discover the real disease, or morbid alteration, on which they all depend.

LECTURE IX.

ON INFLAMMATION.

THE subject of the ensuing lecture is the action of inflammation.

In announcing this, I am anxious to avoid the charge either of presumption in bringing before you a subject of which John Hunter has so fully and admirably treated, or of the want of proper consideration for the value of your time, much of which must already have been devoted to the investigation of this interesting action. Allow me, therefore, to remind you of the wish of the Board of Curators having been officially communicated to me, that those subjects should, if possible, be chosen for the lectures, which could best be illustrated by preparations from the museum. I need not remind you that the causes, effects, and terminations of inflammation, occupied much of the time and thoughts of John Hunter, and that from the knowledge he has communicated respecting this action, and the preparations which he has made and preserved to illustrate his doctrine, principles have been established which must prove useful to surgery for ever. It is my duty to bring the preparations before you, and this necessarily leads to some observations on the facts which they prove, or the inferences which may be drawn from them.

The knowledge of inflammation, in all its variety of causes, effects, terminations, and method of treatment, may be truly said to constitute the basis of scientific surgery; for it is an action entering more or less into the cause, prevention, or cure of every disease which comes under the surgeon's care.

By most authors, indeed by all those not of a modern date, inflammation has been treated of merely as a disease, generally as a species of tumour, and various explanations have been given of it as such, under the term Phlegmon. From the etymology of the Greek and Latin terms used to express it, it might be supposed that there was fire in the part affected by it; and when we consider the kind of pain excited by very violent inflammation, and the ideas which were formerly entertained of the temperaments of our bodies, we cannot be surprised at this inference, or at these terms having been used; they are now, however considered only as figurative, and not as expressive either of the causes, or any of the properties of inflammation

Inflammation will be found, upon due consideration, to be much too useful and too important an action, to be treated of as a disease only; I shall, therefore, neither enter into a description or confutation of what those nosologists have said, who have so partially considered it. Some authors have stated symptoms and effects, in which they suppose it, as a disease, to consist, without attempting to prove their statements: and others have related occasional effects of inflammation, as constituting the real disease.

To John Hunter we are indebted for a much more comprehensive view of it, and for reasoning not founded upon conjecture, but upon facts.

He considered inflammation as an action which took place only in a disturbed state of parts, and which required this new, but often salutary mode of action, to restore them to that state wherein a natural mode of action alone was necessary.

Inflammation, when very violent, or when not properly carried on, undoubtedly constitutes a disease; it is also, occasionally, the cause of disease; but it is often an action used by nature to prevent disease, and is generally the first step towards the cure of all diseases or accidents requiring operations; for incised wounds, or wounds with loss of substance, would neither unite or fill up, without some process depending to a certain extent on this action.

Inflammation must therefore be considered as a general action, of which every part of the body while alive, is susceptible but which it is only called upon to perform occasionally, in consequence of some particular alteration from its natural state. Inflammation cannot be included among the healthy actions of the body, as it is often the cause of disease, and is never present but as a mark of something not perfectly natural either having taken place, or being about to take place in the body; nor can it be included among the diseased actions, as it often takes place to prevent or to cure disease; it therefore is not a primary or natural action, but always a consecutive one; for it is never found in the natural structure or functions of the body.

The action of inflammation may be confined to one part of the body, or it may be diffused over the whole. The first is termed local, the second, general inflammation. The symptoms which characterize it, are various, and the same symptoms are present in different degrees, depending on the part in which it is seated, and on the violence with which it is carried on.

In a part affected by local inflammation, the action of the arteries and the force of the circulation are increased; there is more redness and some degree of tension and swelling. These symptoms must be present in every local inflammation, and are sufficient to constitute it; for the additional symptoms which have been required by some nosologists to constitute inflammation, will be found either to depend on the structure of the part, or on the violence of the action; pain and throbbing are symptoms of this nature.

A prickling or itching sensation is generally felt at first, which, as the inflammation increases, becomes converted into acute pain; the degree of pain varies, depending on circumstances afterwards to be mentioned. The pain is always increased by the parts being pressed on or stretched; it is therefore increased, and produces throbbing at every pulsation of the arteries. Throbbing is always felt when much tension is produced; so is it in parts naturally tense when inflamed, although no pulsation had been perceptible in them when in their natural state. These symptoms may be carried to a considerable extent, so as to impede or even entirely to stop the functions of the part; but to constitute inflammation, it is not necessary that they should be carried so far.

Inflammation is said to be general, when the force and action of the heart and arteries, throughout every part of the body, are increased much beyond their usual state. This is always marked by a full, strong and frequent pulse. The blood, when taken at this time from a middle sized vein, continues longer fluid than it would when taken from a person in health; but when it does coagulate, it forms a firmer coagulum, and when allowed to remain at rest for some time, the surface will be cupped or hollow, and will have that appearance known by the name of size or buff. The tongue is dry and white, and there is a considerable degree of thirst, of anxiety, want of sleep, and loathing of food; there is also universal redness, heat and swelling.

Local inflammation is generally produced by some irritation. Any irritation, mechanical or chemical, will produce it. It also may arise from some general affection of the body becoming local, as from the irritation of fever falling on the lungs, or forming a critical abscess elsewhere, or from the irritation of gout fixing on an extremity, or, as it often does, it may arise spontaneously in a part, at least without any discoverable reason.

Inflammation may also arise from irritation produced by the matter of specific diseases; as when gonorrhea or chancre take place, in consequence of the application of venereal virus, or a small pox pustule, in consequence of variolous matter. These inflammations arising from specific causes, are truly diseased actions, and do not come under our present consideration.

Although we are not always acquainted, in local inflammations, with the morbid alteration of the body, which produces a change in the action of the arteries, yet the change itself is sufficiently evident to our senses, viz. the arteries of an inflamed part are augmented in size, and their action is also increased.

This increase of size, permits a number of the the smaller branches in which formerly none but transparent fluids were circulated, to afford a passage to those globules which give the red colour to the blood; we have a well marked instance of this, in the inflammation of the tunica conjunctiva of the eye.

An increase of arterial branches also soon takes place. This increase can readily be demonstrated in cases of long continued inflammation.

In consequence of the increased action of the arteries, more fluids are sent to the inflamed part, and if it is a part capable of secretion, more fluids are secreted in it; this will of course produce some tumefaction.

The sensibility and irritability of the inflamed part are increased; for when inflammation seizes upon parts apparently in their natural state, possessed of neither of these qualities, it is found to produce them, or at least to increase their natural quantity so much, as to make them discoverable to the senses.

The immediate action of inflammation is in the smaller vessels, for it often begins, and is confined to a spot where none but the smaller vessels are to be found; but though the immediate action is confined to small vessels, yet the trunks from which they arise, are also concerned in the action generally. To prove this, let me instance the difference which will be felt in fulness and hardness, in the pulse at the wrist, on the side where there is a whitlow on one of the fingers, compared with that of the opposite side; the trunk which supplies the vessels of the inflamed part is in greater action, and dilates so as to allow a larger quantity of blood to pass to it.

The pulsation of the arteries of an inflamed part is often not observable at first, but as the inflammation proceeds, the vessels increase so much in size, as to have a perceptible systole and diastole, and hence arises throbbing. This throbbing is felt the most acutely near the middle point where the inflammation began; it lessens towards the edge; and is greater and more painful in proportion to the confinement of the part, and to the unyielding nature of the surrounding structure.

The appearances which spontaneous inflammation puts on, at first are confined to a very small space; usually the inflammation seems to begin at a point, and probably it does so at first, in the cellular membrane; it then gradually occupies a larger space, in proportion to the exciting cause, or as the surrounding parts are disposed to partake of the action. The extension or spreading of inflammation will thus be different, in different parts of the body, and in the same part at different times.

Wherever there is cellular membrane, inflammation always produces some tumefaction; this is greatest near the point where the inflammation began, and will be greater or less, according to the structure of the surrounding parts, and the connection which they have with the part in which the inflammatory action originated. The degree of tumefaction will depend also on the constitution of the patient; thus in a very healthy constitution, the swelling will be found less diffuse than in an unhealthy or naturally irritable one; and when inflammation takes place in a part near the heart, the disposition in the surrounding parts to partake of the swelling, will be less than in those at a greater distance from it.

This tumefaction is produced by some of the coagulable lymph and serum of the blood being thrown out of the cavities of the arteries; the coagulable lymph becomes solid, and unites the surfaces of the parts into which it is thrown; the serum and watery parts are separated from it, and are, by the increase of lateral pressure, forced into the cells of the neighbouring cellular membrane, and not coagulating, from the ready communication of these cells become more or less diffused. Thus in every inflammation of parts possessing cellular membrane, a temporary local œdema must take place round the inflamed part. This œdema forms a very considerable part of the swelling in all local inflammations. Where the cellular membrane is loose, the accumulation of fluid will be the greatest in the most depending part; thus in the leg, it will be greatest when nearest to the foot; in some instances, an inflammation in the groin has rendered the whole of the lower extremity œdematous.

The fluid thrown out and diffused, may only be an increased quantity of that called interstitial, which is constantly thrown out, in a certain quantity, to lubricate surfaces. The throwing of it out does not appear to be of any absolute use in inflammation, it seems to be only accidental, depending upon the additional quantity of blood contained in the vessels, their increased action, and consequently increased secretion. In healthy bodies, where every action is perfectly performed, a much less extravasation of it takes place, than in those whose actions are performed in a less healthy manner.

The manner in which the arteries separate the coagulable lymph, in common with many other operations of nature, is likely to remain concealed from our observation; the coagulable lymph, in cases of inflammation, is thrown out with the serum; it becomes solid and separates from the serum afterwards.

The redness of an inflamed part proceeds from the additional quantity of blood sent to, and circulated through it, and the distention of vessels which did not before contain red blood. It has been ascertained that when a part has more to do than usual, a larger quantity of blood is sent to it; as to the uterus in pregnancy, to the breasts after delivery; and to parts labouring under inflammation. When the inflammation has continued for some time, the redness may also partly arise from new vessels which are formed, and shoot into the coagulable lymph. It has been found that when a part of an animal has been kept in an inflamed state for some time, and the inflammation not allowed to proceed to suppuration or ulceration, its thickness is increased. This is very well illustrated by the preparations of the ears of a rabbit, preserved in our museum, one which was kept in a state of inflammation for some time before the animal's death, and on the head being injected, the ear which was inflamed proved to be much thicker, and possessed many more vessels, than the uninflamed one.

The colour, like the swelling in a true phlegmonous inflammation, is greater in the middle, and gradually lessens towards the edge. It is nearly of a florid scarlet red, but rather paler than the blood contained in the arteries; the blood itself in the inflamed part is scarlet, but from shining through the skin and sides of the vessels it appears to be rather lighter.

The reason why the whole of the inflamed part is of this colour may be, that from the dilatation of the vessels as well as from the increased action of the arteries, the blood passes quickly from the arteries into the veins without undergoing the usual change. In less healthy inflammations the blood is of a darker red, or purple colour.

Pain arises in consequence of the vessels, from distention, pressing upon a part which already has its sensibility and irritability considerably increased. The distribution of nerves is so general that no unusual actions can be produced, or maintained in any part of the body, without some intimation of them being caried to the mind. When any very strong impression is made on a nerve, even though it is of that kind which the nerve may be particularly adapted to convey, it does not produce distinct sensation, for the sensation produced becomes pain. In highly inflamed parts, the impression on the nerves, being greater than any usually made on them; will be that of pain. Any alteration of the solids of the body, if effected too quickly, will be attended with pain: thus if the inflammation is very rapid, a great degree of pain is produced; if it is slow, there is less; it may be so slow that very little if any pain shall be produced by it. The pain becomes more considerable as the parts are unable to adapt themselves to the swelling, as in whitlow and tooth-ach. Where the parts are naturally very irritable and sensible, the pain will be proportionably greater, as inflammation occasions pain in parts, which in their natural state are not possessed of any apparent sensibility. When a pulsation takes place, the resistance to farther distention will be more felt, hence arises the pain in throbbing.

The heat in inflamed parts is to the thermometer sensibly greater than in parts of the same body not inflamed and equally exposed. John Hunter made a number of experiments to prove how much the heat was really increased in inflamed parts. In these experiments he never found the heat so much increased in reality as it appeared to the sensation of the patient and others. He never found the heat in local inflammation to exceed the standard heat of the blood in the interior vital parts.

A man was operated on for the hydrocele by incision; the mercury in the thermometer rose in the fresh wound to 92°; the cavity was filled with lint, and next day the thermometer rose to $98\frac{3}{4}$°; here the heat in the part had increased $6\frac{3}{4}$°, but the standard heat of the body is 99°.

On quadrupeds John Hunter made a number of experiments which are detailed in his treatise on inflammation; but in local inflammation he never could raise the heat to a greater degree than it was at the heart. Why the sensation of heat should be greater in an external part when inflamed, is accounted for from the additional quantity of blood sent to it, and from the sensibility of the part being increased, so as to make the heat more perceptible.

It has been formerly mentioned that the buffy appearance of blood when drawn from its vessels, is not confined to cases of inflammation, but will be formed, in most instances in which the action of the heart and vessels is considerably increased.

It had been asserted, until Mr. Hewson's experiments were made public, that the blood in inflammation was thicker than in its natural state. Medical practitioners had observed, that blood drawn from a large orifice in a vein was more effectual in lessening inflammation, than when drawn from a small one; they therefore supposed that it arose from a large orifice letting out the thickened or vitiated blood more readily: they however mistook the cause from which the advantage is derived, as it is not from the large orifice letting out thickened blood, but from the quickness of the evacuation producing faintness or diminished action.

Mr. Hewson, in his experimental inquiry, has proved that the blood so far from being thicker, is in reality thinner in cases of inflammation. Indeed this thinness is observable to the naked eye, when the blood is first taken from its vessels. The disposition of the blood to coagulate quickly is lessened, and the red globules sink through the lymph and serum to the bottom of the receiving vessel much sooner than in healthy blood. This subsiding of the globules appears to be owing to something more than the lessened disposition of the blood to coagulate, for blood found in the hearts of animals put to violent death, is longer in coagulating than inflamed blood, and yet the red globules are entangled in the coagulum. In some of Mr. Hewson's experiments it was found, that when blood was included between ligatures, and kept at rest in its vessels in the body, although it was ten times longer in coagulating than inflamed blood, yet that when it did coagulate, it entangled the globules; if the buff was produced merely from the slowness of the blood in coagulating, it should have been formed in these cases.

Mr. Hewson also found that in inflammatory cases, the red particles subsided more quickly from the surface of the whole mass of blood, than from the surface of the serum alone. From this we may infer, that the mass of blood is, in cases of inflammation, thinner, and that this thinness does not depend on an alteration of the serum. To prove on what it depended, the following experiments were made:—

One ounce of the serum of blood, the crassamentum of which had an inflammatory crust, was put into a phial; the same quantity of serum from blood which had no crust, was put into another; then a tea-spoonful of serum, loaded with red particles of blood, which had no crust, was added to each: the red particles did not subside sooner in the one than in the other. The inference from this experiment is, that the serum is not attenuated in inflammation.

Portions of serum from healthy uninflamed blood were placed in separate phials; then a spoonful of the same serum, loaded with red particles of blood which had an inflammatory crust, was added to one; and another spoonful of the same serum, loaded with the red particles of that blood which had no crust, was added to the other. There was no difference in the time of subsiding; and from this it may be inferred, that the subsiding of the red globules does not depend upon their increased specific gravity.

From the result of these experiments, we are entitled to conclude, that the greater thinness of the blood, in cases of inflammation, depends on the coagulable lymph; for the whole mass of blood appears to be thinner than the serum, and this thinness can therefore only arise from the coagulable lymph being so attenuated as to dilute the serum.

(This admits of a query, whether the separation and throwing out of coagulable lymph in inflammation, may not in part be influenced by its having become thinner than usual, and thinner than the other fluid parts of the blood.)

The terminations of inflammation, like the action itself, will sometimes produce, and sometimes cure disease.

When the increased action of the vessels, the redness, pain and tension of an inflamed part gradually subside to the natural state, without any unusual evacuation having taken place, inflammation is then said to terminate by simple resolution. Simple resolution is thus a perfect cure of inflammation; and when no particular intention is to be answered by the inflammation continuing, simple resolution is its most desirable termination.

Inflammation may also terminate by resolution, in consequence of some evacuation. This termination sometimes leaves no disease, but occasionally it leaves a dangerous one, as dropsy. Inflammation may terminate from some hæmorrhage taking place near, or in its seat; this is likely to happen when the cause which first produced the inflammation has been lessened, removed, or has lost its effect; for, although the hæmorrhage may lessen the force of the circulation generally, the inflammation cannot subside while its cause continues to act. But in some instances it happens, when the first cause of a local inflammation is slight, that although this cause continues, the parts in time become habituated to it, so that it loses its power over them, and the inflammation subsides, from the natural disposition in the parts to perform only their healthy actions. We have an example of this in parts which inflame at first from pressure or friction, but which gradually become inured to these impressions, so as to be no longer excited to inflammation by the same degree of either. It thus appears, that to continue some inflammations, the cause must be increased.

Inflammation may also terminate in consequence of an accidental evacuation of blood taking place from some part of the body not contiguous to its seat. This termination takes place, occasionally, in cases where the progress of the local inflammation has been very quick, and where the constitution has been affected with some degree of inflammatory fever. The hæmorrhage, by lessening the impetus of the circulation, and weakening the system, diminishes the general inflammatory disposition; and if the cause of the inflammation has ceased to act, by proportionably lessening the increased local action, puts an end to the inflammation.

Inflammation may also terminate by resolution, in consequence of an evacuation produced by a considerable increase of the natural secretions of the inflamed, or of the neighbouring parts. This termination most usually happens to inflammations of secreting surfaces; the secretions are increased, and altered in some respects from their natural state; but not so far altered as to form pus.

Inflammation may also be resolved, from the exhalant arteries of the part pouring out an increased quantity of their usual fluids. When this termination takes place in very small circumscribed cavities, or in the cells of the cellular membrane, it is productive of no danger and very little inconvenience, but only a temporary œdema, which is soon removed by the absorbents; but when the inflammation of the large and important cavities so terminates, more fluid may be accumulated than the absorbents can remove.

Another termination of inflammation is by adhesion. This termination sometimes leaves a slight disease, for it unites surfaces which were only intended to play or slide on each other; but it frequently cures disease, and very often saves the life of the patient. When the internal surfaces of circumscribed cavities inflame, the inflammation often terminates by producing adhesions; and the good effect of this is obvious; for the formation of matter is prevented, which if once formed could have no outlet excepting by ulceration, and would therefore, if in a large cavity, be productive of the greatest risk of the loss of life.

This termination by adhesion, also takes place in all parts connected by cellular membrane. But it very rarely takes place on the inner surfaces of canals having external openings, as it would totally destroy their use, and with their use, the life of the patient; surfaces of this kind have their inflammations more disposed to terminate in the formation of pus. I have seen however exceptions to this as a general rule, and refer for one proof of such exception, to a preparation in the museum, in which a large quantity of coagulable lymph appears to have adhered to the inner surface of the villous coat of the jejunum. In the Museum of Dr. William Hunter which is now at Glasgow, a preparation is preserved, in which a thin layer of coagulable lymph was thrown out on the surface of the villous coat of the intestine, so regularly and extensively, as to be at first mistaken by Doctor Hunter himself for the cuticle lining the alimentary canal. This is another well marked exception.

When inflammation in a part possessing cellular membrane is carried beyond the state capable of simple resolution, the arteries pour some of the coagulable lymph of the blood into the cells of the cellular membrane; this, the instant it has escaped from the arteries, coagulates, adheres firmly to the sides of the cavity into which it has been thrown, and becomes a bond of union between them; in doing this, it forms part of the tumour in phlegmon.

By uniting and confining the cells of the inflamed part, it frequently prevents the neighbouring parts from partaking of the disposition to inflame from the same irritating cause. It tends to prevent suppuration; and when pus has been formed, it confines it to a limited space, and prevents it from being diffused throughout the whole of the cellular membrane, which otherwise it would have been from the ready communication which the cells of that substance have with each other.

If the parts surrounding the cavity of a large abscess are carefully examined, the cells of the cellular membrane, will be found united and impervious, thus forming a boundary, which confines the pus, and prevents it from spreading to other parts. To obliterate the cavities of the cells of the cellular membrane or other cavities, into which the coagulable lymph may be thrown, it is not necessary that the cells or cavities should be distended by it; it is sufficient that their sides being covered by it, should be in contact, and they then adhere. After this pouring out of coagulable lymph, should the inflammation be carried no farther, the tumour may gradually diminish, and the parts may in time resume their proper functions.

The external surfaces of most of the viscera are covered by a fine membrane secreting a limpid fluid, and not containing red blood in the small vessels nearest to the surface, and from these two causes the surfaces of the viscera do not unite, although they are every where in contact. Of this nature are the pleuræ, pericardium, peritoneum, and tunica vaginalis testis. When one of these membranes inflames, were it not for this throwing out of the coagulable lymph, and the effects produced by it, the inflammation would in all probability spread over every part of the membrane; it would thus affect the whole cavity, and by suppurating prove very dangerous in every case, and fatal in most. In such inflammation, the diameter of those vessels which in their natural state refused entrance to the red globules of the blood, now enlarge so as to admit many of them to enter and circulate through their cavities; by the increased action of the arteries, and some other property as yet not known, coagulable lymph is thrown out on the inflamed surface of the membrane; this adhering immediately, and becoming solid, unites such surface to that at the time in contact with it; then vessels from both surfaces, but chiefly from that inflamed, shoot into the lymph and through it, inosculating with each other, and rendering it very vascular.

Should the parts thus closely united, have previously possessed motion on each other, the lymph having become vascular, is soon changed into cellular membrane, and in this state, from the attempts at motion, it gradually elongates, so as to permit the parts to enjoy as much motion as before.

I have stated that the substance thrown out is the coagulable lymph of the blood; its properties demonstrate it to be so. We meet with a proof of its coagulating, and immediately adhering to the surface on which it is thrown, in a vein whose inner surface is inflamed. The coagulable lymph must in this case have been thrown out by the vasa vasorum, for it could not have been separated from the blood in the vein, as the quickness of the motion while circulating would not permit it to either separate or adhere; and when thrown from the vasa vasorum it must have immediately coagulated and adhered strongly to the inflamed surface; otherwise mixing with the circulating blood, it would have been carried on with the current to the heart.

The coagulable lymph is in some instances thrown out in larger quantity than in others, producing much variety in its appearance, as the preparations in our collection shew.

Sometimes it forms a thin smooth layer; sometimes it is in spots; sometimes it is like a rich lace work; sometimes it is very shaggy and rough; sometimes very thick, dense, and in several layers.

At first it is soft, but it soon becomes close and dense in its texture.

We have many preparations in which vessels are seen entering it from the inflamed surface; others which shew the progress of its vascularity, and its change into cellular membrane; and others which prove the elongation of the adhesions.

Although this termination of inflammation in general answers a good purpose in preventing universal suppuration of the larger circumscribed cavities; it proves sometimes to be productive of great inconvenience from uniting parts, which, although at the time in contact from the particular position of the body, are not usually near to each other. I have thus seen the transverse arch of the colon united to the uterus and to the bladder.

Should blood be extravasated into an inflamed cavity which has no external opening, this will not in every instance prevent the termination of inflammation in adhesion; for, after the blood has coagulated, it becomes covered with the coagulable lymph thrown out from the vessels of the inflamed part, into which vessels shoot, and from it into the blood.

It may here be remarked as a curious circumstance, that if blood is thrown from its vessels into a part not inflamed, in all probability it will soon be absorbed; but if it is thrown into an inflamed part, the globules will be absorbed, and the coagulable lymph will remain, and become vascular.

The pain necessarily produced by inflammation terminating in adhesion does not appear to be very great or acute; but in this, of course, there must be much variety, depending on the natural sensibility of the part, the quickness of the inflammation, and its approach towards suppuration.

In dead bodies adhesions of very considerable extent have been found, although the person during life had not complained of any great pain in the part. I have known an universal adhesion of the internal surface of the pericardium taking place, without the patient feeling pain in the part, although ultimately destroyed by the disease. People have been struck with pistol or musket bullets, and have felt little pain at the time or afterwards; they have recovered and lived many years; on their death, their bodies being inspected, the balls have been found with the surrounding parts in a state of adhesion forming a circumscribed cavity to contain them. Pins and needles have travelled from the stomach through several parts of the body, and have been felt first only when they reached the skin, adhesions must have followed their course to close the passage.

The disposition for adhesion appears on all healthy cut surfaces whatever. If we examine the cut surface of a stump, or that which remains after a breast has been extirpated, or after the removal of any other tumour where there is no intention of uniting parts, indeed where union is impossible, we find coagulable lymph thrown out as if it was intended to unite the cut surface with some other part; and although union cannot take place, yet by this action, adhesions are produced in the cells of the neighbouring cellular membrane, so as to prevent the inflammation and consequent suppuration from spreading; thus in all phlegmonous inflammations which proceed beyond the state capable of simple resolution, whether they terminate in suppuration or not, adhesions must take place, for the purpose of setting bounds to the action or disease.

LECTURE X.

ON UNION BY THE FIRST INTENTION, AND ON SUPPURATION.

It is well known to every surgeon, that surfaces formed by a division of parts of a living healthy animal, will unite firmly with each other if placed and retained in contact soon after the separation, notwithstanding there is a considerable loss of substance, provided the division was unattended with much contusion or bruise. Many of the recent improvements in operative surgery have arisen from our knowledge of the nature of this union and of the means of producing it. It has been named, by John Hunter, union by the first intention, and the process employed by nature to accomplish it seems to be the following.

Some coagulable lymph, having escaped from the cavities of the blood vessels on their division, adheres to the recently made surfaces, and by becoming solid, connects them together; the irritation arising from the forcible division of the parts produces a certain degree of increased action of the arteries on each surface, similar to slight inflammation, which enables them to shoot into and through the connecting medium, and to render the union permanent by their branches anastomosing.

It has been already stated, that blood when extravasated and coagulated between the divided surfaces, if only in a small quantity, does not prevent them from uniting; for the coagulable lymph becomes organized, and the red globules are absorbed; but in proportion as the quantity that is left is less, the more certainly will union take place, particularly in those cases where there is no external wound, or only a small one. Indeed, in all cases of wounds with extensive external openings, if much blood is left, it is very apt to lose its principle of self preservation; it then, like all other dead animal matter, will putrify, irritate and prevent union.

Should the position of the divided parts prove favourable, should they otherwise be in health, and the constitution of the patient good, the increased action necessary to produce union is attended with so little tension, redness, pain or throbbing, that many Surgeons have doubted whether it amounts to inflammation.

Should any irritating substance get between the surfaces of the wound, or should the part or the constitution of the patient be unhealthy, perfect union by the first intention must not be expected; inflammation then comes on, increases, and as it approaches towards suppuration, its symptoms become more unequivocally discernible.

This union is not confined to contiguous parts of the body, for not only those parts near each other which have suffered a considerable loss of substance, will unite when placed and retained in contact; but also those which are the most remote. Two cut surfaces of the same shape and extent, the one in the arm, and the other in the leg, if placed and retained in contact, will unite in a few hours.

The disposition to union between parts of animal bodies, is so great, that a part of one animal transplanted into another, has become very vascular and grown from it. This is not unlike the engrafting of trees.

John Hunter's preparations shew this fact beyond the possibility of doubt. There are four instances preserved for your inspection of the testes of cocks which have been separated from the animals to which they belonged, and have been inserted either into different parts of the bodies of the same, or of other animals, and have adhered to them. Two of these preparations shew the injected vessels of communication between the parts. There are several preparations of growing human teeth which have been inserted into the combs of cocks, and the pulps of some of the teeth have been injected from the combs.

The spurs of cocks have been inserted into the legs of hens, and have grown there ; so have the spurs of hens in the legs of cocks; the spur has also been removed from the leg, and inserted into the comb of a cock, where it has grown to a large size, as in the instance of a Maltese cock presented to the Museum by Mr. Keate.

This mode of union by the first intention, was formerly attempted to be explained by the supposition that the two divided surfaces might be brought into such exact contact, that they would unite; the divided vessels attracting each other, and inosculating, so that the blood circulating in a cut vessel should immediately pass into the same vessel beyond the divided part. The absolute impossibility of bringing the divided vessels so exactly opposite to each other, is a sufficient confutation of this theory; but for a moment allowing that the parts could be brought into this exact contact, after the hæmorrhage from the divided vessels has ceased, what power is there to re-open the contracted vessels, or to remove the blood coagulated on, or perhaps in them? To this may be added the unsurmountable objection, that parts supplied from trunks, even in different limbs, will, under proper circumstances, unite as perfectly as simple incised wounds.

There is no other mode to account for the union of divided parts, than by the coagulable lymph forming the first bond of union, a certain degree of increased action of the vessels of both surfaces then taking place, which enables them to shoot into it, and form new branches, inosculating with each other as arteries do in the first formation and growth of the body.

There is indeed one appearance occasionally met with, which would lead us, on the first view, to suppose that divided branches might inosculate; in inflammation of the cornea, when one of the arterial branches on the tunica conjunctiva passing towards the inflamed spot, has been intentionally divided, at first, the cut surfaces are seen to retract and contract; but in a few hours, the inflammation continuing, the artery appears to have united completely, so that no mark of the former division remains. Attend, however, to what gradually takes place after the division; and you will find, that the anastomosing branches, nearest the division, by increasing in size and running straighter, produce this appearance.

This mode of union takes place sooner, and with more certainty, in stout and healthy, than in feeble or diseased people; indeed, in some constitutions, although the divided parts are brought immediately into perfect contact, they will not unite, the powers of life apparently not admitting of the increased action, or slight inflammation necessary to produce union. In other instances, as in very inflammatory habits, the action of the vessels becomes suddenly very great, and pus is formed before the adhesions are perfect. It fails, however, much more frequently in very weak, than in very strong constitutions, as in dropsical habits; and it takes place with much more certainty in young people, from their vascularity being greater, than in aged.

When parts have been divided by a keen cutting instrument they unite readily; but they do not do so if any bruise or laceration has taken place: the chance of union is then lessened, the parts are more disposed to suppurate, and, if the bruise is very violent and extensive, even to become gangrenous.

John Hunter, in his treatise on inflammation, makes a difference between union by the first intention, and union by the adhesive inflammation.

Union by the first intention, he confines to those cases in which blood effused from the cavities of the divided vessels, becomes a bond of union without any increased action of the arteries having taken place to throw it out, and therefore when thrown out without inflammation. Union by the adhesive inflammation, he describes as that which takes place without granulation, where the bond of union is coagulable lymph, thrown out by the action of the smallest arterial branches on the divided surfaces, which action they assume from a certain degree of inflammation coming on. But in either case the bond of union is coagulable lymph, whether it is thrown out along with the globules and other parts of the blood from the cut vessels at the time of division, or separated by the action of the smaller ramifications afterwards; and as the cut orifices cannot again unite or inosculate, in either case before union is completed there must be some increased action of the vessels, and most likely new branches formed to shoot into the coagulable lymph; therefore if we allow inflammation however slight to take place in the one case, there must be something approaching at least very nearly to it in the other.

In the writings of several authors who have treated on the nature and effects of adhesion, much has been said as to the proper means to be employed to produce it, and some very unnecessary and even illiberal controversy has taken place, respecting the comparative merits of ligatures applied by needles, or adhesive straps and bandages, when employed as the means of retaining the divided surfaces sufficiently long in contact to allow of their union. Each mode under different circumstances may be the best. The Surgeon must have recourse to his anatomical, physiological, and even mechanical knowledge, and apply that knowledge to the peculiar nature of the case; always remembering in the re-union of parts which were healthy previous to the division, that the less the process which nature uses in producing adhesion is interfered with, the more certain will the union be to take place; and that, whenever the nature of the wound and the state of the parts will admit of the application of adhesive straps and bandages, these must, on the principle of humanity, be preferred to the use of the needle and ligature, as the last cannot but add something to the irritation which the parts have suffered, as also to the quantity of pain. But whether the needles and ligatures, or adhesive straps and bandages are used, let us never forget, that the circulation of the blood in the vessels of both surfaces intended to be united, is to be impeded as little as possible, as it is by the freedom of that action, that the object we have in view is to be accomplished.

ON SUPPURATION.

When the symptoms of local inflammation have continued for some length of time, and have been carried too high for resolution, or the formation of adhesions, they generally terminate in suppuration.

Suppuration is well known to consist in the formation of a particular fluid called pus, either on the surface, or in the cavities of an inflamed part.

The inflammation which terminates in suppuration, is the same kind of action at first, as that which terminates in resolution or adhesion, and will of course be produced by the same causes; but when suppuration does take place, there is then an alteration of the action.

Besides the symptoms of inflammation running high, various other causes will produce its termination in suppuration, as the inflamed surfaces not being brought into contact; the parts which were divided having been bruised, so that their vessels could neither throw out the connecting medium or shoot into it when left on their surfaces; the violence having been so great as to destroy the life of the exposed surface, so that previous to union, a sloughing of the dead parts becomes necessary; extraneous bodies having been introduced; or the inflammation having at first taken place to expel some irritating substances, as parts of the body which had lost their life, or to free the constitution from some dangerous disease, as in critical abscesses. In none of these cases could advantage be derived from the inflammation having either of the preceding terminations.

Inflammation, when very violent, does not always terminate in suppuration; for it may even be carried too high for this action, and it will then terminate in mortification. Thus previous to the mortification of a portion of strangulated intestine in hernia, the inflammation of the part is often much greater, and becomes more suddenly so, than an inflammation of another part which ends in a copious formation of matter.

It may here be observed, that in gout, the parts affected are often so highly inflamed without suppuration taking place, that half of that degree of phlegmonous inflammation would have been attended with a quick and copious formation of pus.

It has been asserted, that air admitted on a surface which is not naturally exposed to it, will produce an inflammation which always terminates in suppuration. But in emphysema, air is diffused through the cellular membrane of different parts of the body which never were intended by nature to come in contact with it, and no suppuration takes place in these parts.

To this instance it has been objected, that air, passing into cellular membrane from the lungs, loses the power of irritating; but air, from a pair of bellows, has frequently been introduced into the cellular membrane of brute animals, and has been diffused over their bodies, without suppuration taking place in any other parts but those where wounds were made either to introduce it, or to let it out: at these places the wounds suppurated from exposure, and not from mere contact with air. It is therefore, not air, but the continued exposure of a surface, which should have some part of an animal body in contact with it, that produces suppuration; and by this action, an animal substance is actually formed to cover the exposed part.

Some increase of the action of inflammation beyond that which will form adhesions is necessary to suppuration. In inflammations which have this termination, excepting when affecting secreting surfaces, the redness, heat, pain and throbbing are greater. When a person labouring under local phlegmonous inflammation can easily count the number of pulsations in the arteries of the part from the throbbing, it generally happens that suppuration follows.

The constitutional symptoms are also stronger, there is more general heat, there is a greater degree of thirst, and the pulse becomes more hard and frequent.

When a large suppuration takes place in a part near the surface of the body, it usually is preceded by coldness coming on suddenly, and rigors, and these last during the formation of matter are repeated occasionally, and at uncertain intervals. Rigors are always met with when an internal suppuration takes place.

These symptoms continue and increase until the arteries of the inflamed part, instead of throwing out the coagulable lymph and serum, acquire the power of secreting a fluid, which is at first true pus, or is soon afterwards converted into it.

It has already been stated, that in all cases of healthy suppuration, adhesions take place in the surrounding cellular membrane to confine the pus to the inflamed part. After this, in many cases, the hardness, tumefaction, pain and throbbing, gradually decrease, the pulse becomes much softer, and the febrile symptoms which affected the constitution gradually subside.

The period of the duration of any inflammation before it terminates in suppuration, will vary from several causes; and from none more than from the pus being formed on a secreting or on a non-secreting surface. It will vary also from the structure of the parts, the situation of them, the age of the patient, and the peculiarities of the constitution.

The secreting surfaces of all the internal canals having external openings, upon an irritating application, will have pus quickly formed on them, instead of the mucus which is their usual secretion.

From some ingenious experiments made by Sir Everard Home, and published by him in a prize dissertation, it has been ascertained, that a fluid bearing every characteristic mark of pus, has been formed on one of these surfaces within five hours after the application of the irritating matter.

These surfaces are also excited to suppuration by a much less irritating cause than would produce that effect in other parts of the body; and for this good reason, that the termination of their inflammation in adhesions, would totally destroy their use, and in many instances would destroy life also: as in the alimentary canal, and in short, in all canals which have mucous membranes and external outlets. Another experiment made by Sir Everard Home has proved, that pus can be formed in twenty hours after an irritating application has been made to the surface of the skin upon which a blister has been raised.

In parts which do not naturally secrete, but which are very vascular, as in muscles, it may be from two to three or four days before suppuration is completed; and in parts which are not so vascular, it may be longer. When the symptoms of inflammation run high, suppuration will take place sooner than when they are languid, and those parts which are nearest to the heart will suppurate sooner than those which are at a distance from it. It takes place sooner in children than in adults; and sooner in adult persons than in aged.

It may here be remarked, that although secreting surfaces suppurate very soon when inflamed, a gland is generally longer in suppurating than any other part inflamed in a like degree.

For the reasons above given, no precise time can be fixed for suppuration to be perfected in, but the rigors and shiverings which occur, are the surest indications of its taking place.

Some of the structures in the body do not admit of suppuration; tendons, for example, are capable of inflammation; but when this action is carried beyond the adhesive stage, they die and slough away. Sometimes, indeed, we meet with a kind of attempt in young people for a tendon to suppurate; but this action has never been completed, as the fluid formed has not been true pus, but rather a thin ichor or sanies.

When any new surface of an animal body is formed and exposed by violence, on the stoppage of bleeding the usual symptoms of inflammation come on and increase; the edges of the wound are removed to a greater distance from each other; they also become red, hard, and swollen; the whole of the surface looks redder, and adhesions form in the cells of the exposed and neighbouring cellular membrane. A thin discharge of fluid then takes place, which as it mixes with the remains of the coagulated blood acquires an offensive smell; this discharge gradually becomes clearer and less offensive, resembling more pure serum and coagulable lymph; it then becomes of a whiter colour, and thicker in its consistence; and in healthy constitutions, about the end of the third, or perhaps on the fourth day, it becomes pure pus. When this is accomplished, the inflammation gradually subsides.

The seat of an abscess is probably at first in the cellular membrane of the part; in its formation the usual symptoms of inflammation occur, and the tumour increases in hardness, pain and throbbing. Coagulable lymph is thrown out, which may occasion the hardness perceptible, at first, in the middle of the tumour, and the watery parts of the blood are more or less diffused in the cells round it; the vessels in the middle then gradually acquire the power of secreting pus.

When an abscess is opened early, a mixture of coagulable lymph and pus is found in its cavity, and the earlier it is opened, the greater is the proportion of coagulable lymph. This circumstance gave rise to the expressions of the abscess not being ripe, or the matter not being properly concocted.

The action of forming pus may begin at two or three points in the tumour at once, and then become general, these points extending their surfaces and soon running into each other. The cavity of the abscess is then enlarged by the absorption of the surrounding solids, at first, chiefly of the cellular membrane. Previous to this absorption, the coagulable lymph is poured into the cells immediately surrounding the abscess, so as to unite their surfaces and confine the matter to the part. In abscesses which take place in very vascular parts of the body, as in the liver, it often happens, that in addition to this union of the cells of the cellular membrane, a coat of coagulable lymph is thrown out from the whole of the internal surface of the abscess, which, by coagulating very firmly, confines the whole of the formed pus in a distinct cyst.

When the pus is fully secreted in an abscess, the local, as well as general symptoms usually abate; the tumour becomes softer, so does the pulse, and, if the situation of the abscess admits of it, a fluctuation of the matter will be perceived; that part of the tumour which at first was the hardest, now becomes softer than the surrounding parts.

Sometimes, however, the symptoms continue and increase until the matter is discharged; this depends much on the seat of the suppuration, and always happens when pus is formed in parts which are not easily absorbed, and which will not readily yield, as when it is formed in the neighbourhood of, and is confined by bones, ligaments, or fasciæ, or when it is very deeply seated.

It is well known, that an abscess may have its matter absorbed without any opening having taken place; or, as is more usual, the pus may work its way to the surface, and there be discharged by an external outlet.

The first of these processes occurs the most frequently in the suppuration of glands; but it occurs also in parts not glandular, and also more frequently in specific, than in common suppurations, as in scrofula. In these cases, the cause of the inflammation and consequent suppuration no longer continuing to act, the arteries cease to secrete pus, and the absorbents begin to remove it; the bulk of the tumour gradually diminishes, the pain ceases sometimes long before the absorption is completed, the sides of the cavity gradually come into contact, and unite as in the adhesive stage of inflammation.

In most instances, the matter of an abscess is discharged by an external opening.

There are a variety of actions in an animal body, which no information we are yet possessed of, has enabled us perfectly to explain; the manner in which pus finds its way to the surface of the body is one of these, and concerning which, there have been a variety of opinions.

The older writers on this subject, and indeed some of later date, have supposed that pus was a menstruum which dissolved the solids, and by this property produced a passage for itself to the surface.

Others have supposed that pus was a ferment, having the power of converting both solids and fluids into its own nature. But neither of these theories will account for the action being confined to one part only of the cavity of the abscess; namely, to the side nearest to the surface of the body; for if it was by either of the above means, the abscess should continue to be equally enlarged all round.

No one now doubts, but that the absorbent vessels remove the parts between the cavity of the abscess and the external surface; but we know not how they are excited to do this. We cannot account for their being stimulated by the pressure of the tumour, for any substance situated internally must produce an equal degree of pressure all round, therefore, were it so, an equal degree of absorption of the whole surrounding parts would take place; but absorption takes place on one side only; it cannot therefore be accounted for on the mechanical principle of pressure; it seems to depend upon some general law of the constitution, the wisdom of which we see by its effects; though of its immediate cause we remain ignorant.

If it was produced by pressure only, the absorption should be greatest in the parts affording the least resistance, as when an abscess took place in the psoas muscle, an absorption of the peritoneum should be produced, and the pus should be emptied into the cavity of the abdomen. This is not however the case, for there is an effort made by nature to prevent it, by strengthening the boundaries of the abscess in that direction, as more danger would be incurred by the pus escaping into the abdomen than could be occasioned by the continuance of the abscess. Instances of such abscesses forming adhesions and being discharged externally will occur to the recollection of every one present.

Next to the external surface of the body, the parts into which abscesses are most likely to burst are the canals which have a natural outlet for the matter, such as the alimentary canal, and the trachea.

In the progress of the pus to the surface of the body, it is found that the parts which are of the least consequence, and which can the most easily be spared, are in general absorbed in preference to those which are more important. Thus an abscess does not always take the most direct rout to the surface; but frequently pursues a very circuitous one: cellular membrane being absorbed in preference to muscles, and muscles in preference to arteries and nerves.

The force of gravity sometimes directs the course of the outlet of the matter, and long sinuses are thus formed; this happens more particularly in cases where the matter is very deeply situated, and where there is more than common resistance to its taking the nearest, and even, perhaps, the safest way to the skin.

A variety of opinions have been entertained concerning the way in which pus is produced. The serum and coagulable lymph of the blood thrown out as such from the vessels, and then by fermentation undergoing a change, have been supposed to be converted into pus. But so far as we can discover from the putrefactive fermentation, or from any mode of chemical analysis yet known, the properties which pus possesses are different from any which can be obtained from these fluids.

Pus has been supposed to arise from a dissolution of the solids, and when once formed, to have a power of converting solids into a part of itself. This hypothesis however is readily confuted, for although in very large abscesses there may be a loss of substance, yet this loss will be found very small indeed, in comparison to the quantity of pus formed. Very large quantities of pus are formed constantly on the surfaces produced by blisters, without any loss of substance ; and several quarts of pus have been found in the larger circumscribed cavities, without any breach being discovered in the membranes lining them; as in the thorax and abdomen, when the pleura and peritoneum have been entire.

If the old opinion of pus being acrid, corrosive, or being a menstruum, was just, every part upon, or in which it was formed, would be corroded by it; instead of which, in healthy sores, it rather seems to protect and to be in perfect harmony with the granulations.

If pus is considered as a ferment, how can the first formation of it be accounted for on mucous membranes where there is no breach of surface, or loss of substance ; and why, on these surfaces, does it ever cease to form when once begun? for although pus is no longer formed, these surfaces still go on secreting their mucous, so that secretion of some fluid is never discontinued; and if pus was a ferment acting on the fluids, the formation of it when once begun ought never to cease.

If dissolved solids enter into its composition, how is it first formed in an abscess, before there is any particle existing there capable of dissolving the solids? Matter shall frequently form in an abscess, remain there stationary for weeks or months, and at last be absorbed, when the abscess shall heal without an external opening. But if pus is a ferment, or has dissolving powers, how can we account for an abscess ever being stationary, or for it ever healing?

It has also been supposed, that blood when extravasated, would become pus; we know that when extravasated from an artery, as in spurious aneurism, it does not become pus, nor is pus found in any of the cavities of the body, until inflammation has taken place in them.

From some experiments, in which a piece of beef was placed in a sore, and after a time was found to have diminished in weight, it was supposed to be ascertained, that the solids were melted down by pus; but this experiment proved nothing; for living and dead animal matter are possessed of different properties; a living finger placed for the same length of time in the sore, would have suffered no change; but even sloughs, which are dead animal matter, will remain for days and weeks immersed in the matter of an abscess or sore, without being melted down, or formed into pus.

The weight of a piece of meat being diminished, after having been some time in the cavity of an abscess, does not prove that part of it has been converted into pus; for if placed in common water for some time, it will lose in weight. From an experiment made several years ago by Sir Everard Home, and which since has been repeated with nearly the same result, it was found that a piece of meat when placed in pus out of the body, and kept nearly in the same degree of heat as that of the body, was dissolved several hours sooner than a portion of meat of the same weight, kept in the cavity of an abscess or sore in the living body, where the pus by being constantly secreted, was consequently changed.

When kept in the same unchanged pus out of the body, its loss of weight may be accounted for by its putrifying sooner, this process aiding its dissolution. If pus was intended to have a corroding quality, the meat in the sore in the living body, should have been dissolved first; but so far from that being so, it lost little more of its weight in a given time, than the same quantity of meat of a similar quality did, when placed in a pure animal substance, which had not the least corroding quality, as in calf's foot jelly, without wine or any vegetable substance mixed with it.

Pus seems to be formed by a secretion of the vessels of the inflamed part; for pure pus cannot be formed by any chemical combination of the solids or fluids of an animal body; it does not exist originally in the body, but is formed at the time; and any fluid so formed, either in glands, or by the extreme branches of arteries, is said to be secreted. We may fairly infer therefore, that pus is secreted either by newly formed arteries, or by the original arteries having undergone some change necessary to produce it.

ON THE PROPERTIES OF PUS.

The pus which is formed on the surface of healthy granulating sores, readily separates from the granulations beneath, and then appears to be an opaque, equal fluid, of a whitish or pale yellow colour, unctuous to the feel, and in consistence nearly similar to fresh cream; it has a mild mawkish taste; it is inodorous when cold, but when warm has a peculiar smell. Pus is specifically heavier than water, for it sinks in that fluid, and is probably like the blood, about one-thirty-eighth part heavier; it does not unite with water in the cold of the atmosphere, and when exposed to heat, does not coagulate, but evaporates to dryness; when pure and unmixed with other fluids, it does not readily go into putrefaction.

When viewed in the microscope, it appears that its colour and consistence depend on small round globules; nearly similar in size to those found in milk, but rather less than those which are found in the blood while they retain their colouring envelope; they are nearly white in colour, and a little opaque; and they appear to swim in a transparent fluid. They are more numerous in healthy suppurations, than in unhealthy ones, and therefore in the first, occasion the pus to be thicker.

From an experiment made by Sir Everard Home, (and here I beg to acknowledge my obligation to him, for the information he has given of the properties of pus, and which I have not scrupled to make use of,) he concludes, "that pus, at its first formation, does not contain globules; but is a transparent fluid, of a consistence in some sort, resembling jelly; and that the globules are formed while it lies upon the surface; requiring in some instances, fifteen minutes for that purpose." From another experiment he infers, that after the fluid is once separated from the vessels, the formation of globules is a change, taking place within itself, independent of the granulations which secrete it.

And in the Croonian lecture of last November, after stating Mr. Bauer's discovery of transparent globules forming in the serum of the blood, Sir Everard observes, that this makes the resemblance between blood and pus greater than has generally been believed.

The fluid in which the globules swim, is capable of being coagulated by a saturated solution of sal ammoniac, which serum is not, nor are any of the other animal secretions.

Pus had been submitted to various tests to distinguish it from mucus; the following are, I believe, the most certain. Pus is not viscid or ropy; mucus is so to a great degree; thus when mucus is placed between the finger and thumb, and these parts are separated, it draws out to a fine thread. Pus has globules; mucus has none. Mucus when viewed in a microscope, puts on a flaky appearance; so do all the chemical combinations of animal substance.

In having globules, pus has some affinity to several of the other animal fluids; but in some properties it is different from all the other fluids. It differs from the chyle, in its globules being rather larger, and in its not coagulating when exposed to air or heat; it differs from milk, not in the appearance or size of the globules, but in not being coagulated by runnet, and in containing less oil and sugar; it differs from the blood, in the colour and size of its globules, and in its globules not appearing so readily soluble in water; but these circumstances apply only to the globules of blood when invested with their colouring envelope; their appearance and other properties are nearer to the globules of pus when this envelope is separated from them: its great difference from blood, consists in the fluid in which its globules swim being coagulable by a saturated solution of sal ammoniac.

A fluid formed in consequence of inflammation, possessing globules, and having the fluid in which these globules swim, capable of being coagulated by a saturated solution of sal ammoniac, may be said to constitute pus.

It has often been attempted to distinguish pus from mucous, by chemical tests, as by solution in menstrua and precipitation; but all animal substances when held in solution by acids and alkalies are in the same state, and the precipitations are found from experiment to be the same in all, viz. a flaky substance, without any regular form.

LECTURE XI.

ON ULCERATION, GRANULATION, CICATRIZATION, AND MORTIFICATION.

Inflammation will also terminate in ulceration, and in this action the absorbent vessels take the lead of the arteries. It is now well known, that the absorbent vessels are constantly employed in modelling the form of the body, removing from some surfaces while the arteries are depositing upon others, and in this way preserving the relative situation and proportion of every part, while the whole increases in size. In health, the actions of these two sets of vessels are in exact proportion to each other; but in some local diseases the state of the affected parts being such that they are unable or unfit to carry on their usual functions, the absorbent vessels are then employed to remove them, and the action by which they perform this is termed ulceration. The different kinds of ulceration producing different appearances, the circumstances under which they happen, and the treatment which they require, afford a vast field for observation and inquiry, but this cannot be entered on here; the observations which I shall now make will be confined, as much as possible, to those circumstances that occur in the most simple and least diseased state of this process, and which are the most connected with inflammation and suppuration as general actions.

By ulceration is understood a solution of continuity (as it has been technically termed,) with loss of substance in any part of the body, taking place gradually by some internal action, and discharging from the surface affected by it either pus, or some vitiated fluid.

In wounds there is also a solution of continuity, but in them this arises instantaneously from some obvious external cause, and often without loss of substance; in ulceration it is gradually produced by some long continued irritation; thus wounds and abscesses are often the beginning of ulcers, and in all ulcers there must be some loss of substance. Although, in the beginning of abscesses, and on secreting surfaces, the formation of matter may precede ulceration, yet on non-secreting surfaces, and sometimes in wounds, a certain degree of ulceration first takes place, and is soon succeeded by the formation of pus.

It is well known that violent pressure on the external surface of the body will, if long continued, produce ulceration: inflammation first takes place when adhesions form round the compressed parts, and ulceration then begins.

The mode of producing ulceration, continually practised by the common people in making of issues, may be given as an example of this; a pea is pressed on a part by some flat substance, and secured by a bandage; this pressure acts as a stimulus to the absorbent vessels to remove the part compressed, as the next best process to the removal of the substance which caused the pressure, for over that these vessels have no power.

Violent pressure long continued, or in fact any violent and long continued irritation on a part will, in time, bring on ulceration; and those parts which are the most deficient in the active powers of life will go the soonest into this action; thus the want of power in a part to support or keep up inflammation is often the cause of ulceration beginning.

The length of time required for ulceration from pressure to take place, and the degree of pain attending it, must be different in different parts of the body; they must be dependant on the degree of pressure used, and upon the sensibility and irritability of the compressed part. In proportion to the quickness of the ulceration the pain is generally great; this may arise from very active inflammation, producing adhesions and suppuration, and from ulceration taking place in nearly the same part and at the same period of time.

Ulceration takes place more quickly, and from a less degree of pressure, when such pressure is made on the inside, than when applied on the outside of the body. The effect of outward pressure when not excessive, is at first to produce a thickening of the parts, to enable them to resist it, or inure them to it; thus the hands of hard-working people, more particularly in the part where they hold their tools, have the skin much thickened; and in all people who walk much, the integuments of the soles of the feet are much thicker than those of any other part of the body; but a very slight degree of pressure made on the integuments either of the hands or feet from within, would produce ulceration. It appears therefore, that there is much resistance made by nature to any substance attempting to produce ulceration, or to enter the body from without; but that any substance of an extraneous nature pressing from within to get out, will be assisted by a disposition in the parts compressed immediately to ulcerate.

Ulceration, however, does not depend solely upon pressure; for were this so, the whole of the compressed parts should indiscriminately ulcerate: but we find in the process of matter coming forward to the surface of the body, that the parts of the least importance to life are the soonest removed, as cellular and adipose membrane, while more important parts, as blood vessels and nerves, are left to the last. It is curious, that in the progress of ulceration there should be this discriminating power; but so it is, and it cannot be accounted for by any mechanical or chemical cause.

There are parts of the body which cannot ulcerate; the cuticle is one of these. This is also the part which is thickened to resist ulceration when the pressure is from without; and when the pressure is from within, it neither thickens or ulcerates, but bursts from distention. It thus happens, when ulceration and suppuration begin in parts covered with a thick cuticle, that they are attended with much pain and irritation, from the cuticle neither ulcerating or bursting; on the contrary, when these actions begin under a thin cuticle, from its bursting early these unpleasant concomitants are much lessened.

In parts covered with a thick cuticle, a greater disposition is found for the cuticle to separate from the cutis than to burst, and as it is not affected by ulceration, this disposition is often the cause of producing when it does burst, an inflamed and irritable surface of considerable extent, but this we prevent by cutting through it in proper time; thus in whitlow, if left to itself, the cuticle usually bursts at the angle of the nail; and inflammation attended with suppuration under the thick cuticle of the palms of the hands, or soles of the feet, will extend over a large surface, unless the cuticle is divided early.

Although ulceration takes place in an inflamed part, inflammation does not cease in the neighbouring parts; the spreading ulceration is always preceded by the adhesive inflammation: and in deep seated abscesses, in consequence of this, the pus is discharged at the surface of the body, without risk of its passing into the larger circumscribed cavities, and thus life is often preserved. We have instances of this in abscesses of the liver or lungs bursting externally.

All parts which are naturally weak, or have become so in consequence of disease, and all new-formed parts, are disposed to go into ulceration from a slighter stimulus than would produce that action in healthy, strong, or originally formed parts. Thus parts situated at a distance from the heart ulcerate sooner, the same cause being applied, than those which are near it. The gums, tongue, and other parts of the inside of the mouth, when they have been weakened by a long course of mercury, will ulcerate from a cause which would not have affected them when in their natural health. The cicatrices of sores ulcerate sooner than the surrounding old skin. Formerly, when scurvy was the almost inseparable attendant on a long sea voyage, it was remarked, that tumours situated on bones, as nodes or exostoses, being diseased parts, ulcerated sooner in persons affected with that disease, than the callous, or new-formed substance uniting bones which had been accidentally divided. Here, if we may be permitted to use the expression, we have other proofs of the discriminating power of ulceration.

ON GRANULATION.

When parts of an animal body have suffered a loss of substance either by violence or ulceration, or when having been intentionally divided they have not been allowed to unite by the adhesive inflammation, the process by which the loss is made up, and the union effected, is granulation, or as it was termed by the older surgical authors, incarnation.

Healthy granulations are fleshy substances of a florid red colour, with small irregular roundish points arising from the inflamed surface. Some of these points are occasionally higher and larger than the rest; but the granulations are the most healthy when they are small and equal. They are also more healthy when of the florid red colour, than when they are either pale, or of a dark red colour.

Suppuration is always necessary to the formation of granulations on an exposed surface; we therefore not only find the granulations covered with pus, but that pus is formed before they arise from the surface. Granulations however do not follow every suppuration, for the suppuration of secreting membranes and internal canals does not produce granulations, unless there is a breach of substance, or a continued exposure; the surface is then altered, and the granulations arise from the altered surface. No exposed surface will granulate until its inflammation is over, and a full suppuration has taken place; nor will granulations arise in an abscess until its cavity has been exposed, or in other words, until it has become an ulcer.

So far as can be judged from anatomical investigation, such as injecting, and then viewing granulations in a microscope, their formation and texture appear to be this:—first, that an exudation of coagulable lymph takes place from the vessels of the inflamed surface, into which, vessels from the surface shoot and increase, by branching off in every direction. This seems also proved by what takes place in many sores; the lymph is seen coagulated, and at first merely adhering to the surface of the sore; in a few hours, it becomes so vascular as to bleed upon being roughly touched. This increase of vessels occasions the great redness of granulations, for while forming, they are, perhaps, the most vascular part of the body.

When granulations, which have been minutely injected, have been viewed with the usual double convex lens, the trunks of their blood-vessels have appeared to enter the basis of each granulation, and to approach the apex in nearly parallel and somewhat regular lines, and small branches have been seen proceeding from the trunks, and running towards the surface but taking a more oblique direction, and in some places uniting or inosculating. When the surface of a part is covered with granulations, the suppuration is not discontinued, for the new vessels retain the property of secreting pus, as well as the power of shooting out, elongating and increasing by forming new branches. Not only arteries and veins shoot into granulations; but they also have their share of absorbents, and of this, we have proofs in various substances having been absorbed from the granulating surface of a wound.

From the pain which is produced by irritating granulations, we cannot doubt of nerves also entering into their composition. These vessels and nerves are connected to each other by some uniting substance, which has always appeared to me to be at first coagulable lymph, but afterwards to be changed into cellular membrane.

Sir Everard Home, in the Croonian lecture of the year 1817, informed the Royal Society, that pus in its inspissation had canals formed in it by carbonic acid gas, similar to those which he had described as taking place in coagulated blood. In his late Croonian lecture, he states, that in the formation of granulations pus undergoes nearly the same change that coagulated blood does when it becomes vascular.

To ascertain what took place in the formation of granulations, he selected a healthy ulcer upon the leg, and examined the appearance of the sore with a double convex lens, which magnified about eight times; he requested Mr. John Griffith, a very intelligent pupil of St. George's Hospital, to look at the sore, as well as himself, upon every occasion on which it was examined, and no change is mentioned to have taken place that was not distinctly seen by both. The surface of the sore was uneven, being made up of eminences and hollows. The eminences consisted of small clusters of tortuous blood-vessels; the hollows were filled with pus. After the sore had remained exposed from five to ten minutes, a very thin pellicle covered the whole surface; this was of so transparent a nature, that through it a number of small bubbles of gas were seen to make their appearance in different places; in a few minutes more, horizontal canals of different sizes, filled with red blood, taking different directions, and anastomosing with one another, were seen to form. In some places there were red points, the terminations of perpendicular canals that had been stopped in their course by coming against the pellicle. There were also occasional specks of extravasation from one of the horizontal canals bursting through the pellicle.

Mr. Bauer made one drawing of the sore after it had been exposed sixteen minutes, and another on the following day, shewing that the canals formed on the first day, had on the second become permanent tubes, and had been covered by a cuticle. These two drawings are annexed to the description. Sir Everard, on another exposure of the sore, immediately washed away the pus with water at the temperature of 95°, and left it exposed for ten minutes, but none of the former appearances were produced; he infers, therefore, that the presence of pus is necessary to their taking place. Cold water having the power of coagulating pus more rapidly than simple exposure to the atmosphere, Sir Everard applied water at the temperature of 65° to a sore after it had been exposed fifteen minutes under the common circumstances, and of which a drawing was taken previous to the application of the water; in ten minutes after the application a second drawing of the same surface was made, shewing to how much greater extent the appearances had taken place, and thus proving that the degree of coagulation was the regulating cause of the effects that followed.

Sir Everard Home then poured a saturated solution of sal ammoniac at the temperature of 45° upon the surface of the sore, the pus almost immediately became curdled, and tortuous canals were every where seen in these masses of coagulum; there was a great uniformity in the canals; they were of the same size, running first in a straight direction, and terminating in a spiral turn and a half, the end of which was extremely small; they were all filled with blood. Some of the coagula of pus were more elevated than the general surface, and large canals filled with red blood were seen passing over some of them superficially, without any smaller ones in the immediate neighbourhood. To ascertain whether there was any vascular basis with which these canals were connected, he passed a tolerably large crooked needle under one of them, bringing out the point on the opposite side, so that the canal was distinctly seen above the flat surface of the needle, he then withdrew it and there was not the slightest degree of extravasation of blood. This was repeated on several different sores without any appearance of blood escaping, or the person having the slightest pain, affording, he says, a sufficient proof of the canals being formed in the pus immediately on its coagulation, before any other approximation to living animal solids had taken place. Sir Everard has thus attributed to coagulated pus the same power of becoming vascular that was hitherto supposed to belong only to the blood when coagulated.

Some apology may be necessary for the time I have taken in relating the above experiments, particularly as they are now published in the last volume of the Philosophical Transactions. I have formerly stated that I conceived it to be the duty of the Lecturer to bring before his audience any new matter connected with the subject of the lectures of the season, that had recently occurred, if it should be at all likely to improve, or lead to the improvement of their professional knowledge. The above experiments having been made by one of our present governors who has always been most forward in promoting the improvement of surgical science, I have endeavoured to relate them, and the inferences which he has drawn from them, as concisely as the nature of the subject would permit. Sir Everard's account of them will, of course, be read by those who are interested in investigating such important actions as those of suppuration and the formation of granulations.

Whatever parts of the body granulations spring from, they have all, at first, the same appearance; those which arise from a surface of bone appear exactly similar to those which arise from muscle, or any other soft part. By a power in the system, although we know not the means by which this power is regulated, they are afterwards changed into the substance of which they are meant to supply the loss.

The granulations of an exposed surface have always a disposition to shoot towards the skin, so that whether they arise from the bottom or the sides of a sore, they all have this tendency; but those which arise from the bottom or deepest part of a wound are generally more considerable, and have also a quicker growth than those which arise from the sides or more superficial parts.

The granulations however, which arise from the inner surface of an abscess where there is a small opening, or from a circumscribed membrane where the opening is small, will often be found to shoot as it were almost to a central point, leaving a straight passage from that point to the skin.

The inner surface of the cutis hardly ever granulates, it will scarcely allow the granulations from other parts to unite with it; and sometimes it will not allow of the least union between them.

Healthy granulations, when they come in contact, are disposed immediately to unite with each other, and continue to unite and sprout out until the whole of the loss of substance which a part has sustained is repaired, and the cavity filled up entirely to the surface. From whatever surface granulations spring, if kept in contact, they will unite;

those of bone with those of muscle; those of dura mater, in a deficiency of bone, with those of the scalp; those of the intestines with those of the parieties of the abdomen, as in the case of an artificial anus.

There must be a disposition in granulations as they fill up a cavity, gradually to contract themselves, otherwise they would render the part where the cavity had been situated larger than before the loss of substance. We see this disposition very strongly marked in those sores which happen in parts where the skin is loose, by the great diminution which takes place in the size of the sore without any addition of new skin. It is practicable, and often necessary, to assist this disposition by art.

In some situations of sores the granulations cannot possess this power of contracting to any great degree; this is the case when they arise from bone, or from a surface rendered very hard by previous adhesive inflammation.

The mode of union in healthy granulations has been supposed to be this; the extreme branches of the vessels of one granulation where they come in contact with those of another, inosculate, and by this union change their action from secretion to that of circulating blood, retaining or acquiring the power of forming new branches, which at first secrete and afterwards unite as the others had done.

It is not difficult to distinguish between an ulcerating sore which is still spreading, and a granulating one which is healing up. In the first the skin appears to be somewhat notched, the sore discharges a thin matter and has unequal pits or hollows in it; the skin also more or less hangs over it, and in some places appears turned out. In the second the skin becomes more rounded and the surface of the sore more equal, florid, and convex; it discharges likewise from its surface a thicker matter.

Those granulations which are of a florid red colour are more disposed to unite, than those which are either of a pale red or darker livid colour. There seems to be too little blood to perform the necessary functions in the first; and too little action, producing an accumulation or stagnation of blood, in the veins of the second.

It sometimes happens, in the same patient, that the granulations of a sore on one part of the body shall appear florid and the sore shall heal soon; and those of another sore in a different part, shall have a livid appearance and the sore shew no disposition to heal. This is generally found to depend on the situation of the sore not allowing so free a circulation to the blood. It often will be found that the granulations of a sore shall assume a florid colour soon after the patient has been placed in a recumbent position, although they continued of a dark colour so long as the patient was erect. This may be one reason why sores on the legs are generally longer in granulating than those nearer to the heart. In granulation, as in inflammation and suppuration, we find that the parts nearest the heart go best into and through these actions.

An inflamed and suppurating surface if fully exposed will very soon granulate; but a very deep-seated abscess when opened, will shew very little disposition to granulate if the opening is small, and frequently none whatever until its cavity is more exposed. If this is not done it is apt to become fistulous. If any granulations have at first taken place they shew no disposition to unite, and the secretion of pus becomes changed into a thin sanies; upon the cavity being more extensively opened, a favourable change will take place in the granulations, healthy pus will be formed, and the cavity will be filled up.

It does not follow, that there must necessarily be ulceration or a loss of substance previous to the formation of granulations; for if the surface of a natural circumscribed cavity be exposed, and the sides of it kept from contact, it will inflame, suppurate and granulate, without having suffered the least loss of substance, as the cavity of the tunica vaginalis testis, in the cure of hydrocele by incision.

In parts which have not been exposed, where substances have been torn through and the extremities of the torn parts removed and kept apart from each other, these parts have been united by a substance apparently formed by granulations which were never covered with pus on their surfaces. This seems to be the case in the union of fractured patellæ by ligament. If pus was secreted in this case it would be accumulated in the cavity of the knee joint and form an abscess there; as there is no exposure, perhaps the secretion of pus is not necessary; the coagulable lymph of the blood thrown out gradually and in properly limited quantities may be sufficient for the formation of this substance.

In healthy sores when granulations rise to a level with the skin, they stop and the skin shoots over them from the edge of the sore. Sometimes, however, they will rise higher than the sound parts, forming a projecting cicatrix if skinned over. At other times they shall be skinned over before they reach the surface, forming a hollow one. In either case, by the application of bandages and other means, the surgeon has it in his power generally to prevent an imperfect cicatrization.

Cicatrization is the covering of the wound or new formed parts with skin. The new skin in most instances appears to shoot out from the edges of the old, over the surface of the nearest granulations; but in other instances it has been found to begin in a middle point of the granulations, and gradually to extend towards the circumference. This happens the most frequently in ulcers of the lower extremities, in cases where the granulations of the edge remain unhealthy, after those in the middle of the sore have become sound.

In general, however, when the granulations have reached the margin of the sore, they stop their growth, and also begin to contract themselves, sometimes so much, as to tuck down the old skin with them; the edge of the sore then loses its red colour, and a thin film of a bluish white appearance gradually extends itself over the whole surface. So long as the sore retains a red edge, it is not a healing one.

Besides the power in the granulations of contracting themselves, there appears to be a similar power in the edge of the cicatrizing skin which assists the contraction of the granulations, and is perhaps, even more useful in lessening the cicatrix of the wound or ulcer, drawing the mouth of it together like a purse. This contractile power is chiefly in the new skin, for the old skin bounding the cicatrix does not lie smooth, but is thrown into folds or plaits.

This explains why wounds or ulcers which are round in shape are longer in healing than those which are irregular or long, for it is easier for the granulations and contractile skin to bring the sides of an oblong cavity together, than to bring the circumference of a circle to a point.

Nature seems to have a great disposition to save as much skin as possible; the power of contraction in the granulations and new skin aids this disposition, and at the same time, greatly expedites the healing of the sore.

More new skin must necessarily be formed in the cicatrization of sores in some situations than in others, for in some parts the skin is naturally tense, and the granulations or the surfaces they spring from may have some connection with bone or other immoveable parts, as with the tibia and upper part of the cranium.

In other parts, the skin being loose will admit of being drawn in, so as to make the cicatrix comparatively small, as in or near the scrotum, where a most extensive sloughing of the skin, shall have a very small cicatrix when the parts are healed.

When the skin has suffered much from extensive burns, it requires much care on the part of the Surgeon, so to place the body or parts of it which are cicatrizing, that a proper quantity of new skin shall be permitted to form; otherwise most unpleasant and inconvenient adhesions and contractions will ensue.

The new skin, although it is at first redder than the old, afterwards becomes paler, has a smoother surface, and appears more on the stretch. It does not retain so much vascularity as the old possesses, and as I formerly have observed, goes into ulceration from a less exciting cause.

The rete mucosum, when it has been destroyed, is long in forming; this we find in blisters, where sloughing has taken place, and in the scars of negroes, the scar is at first white, but after a time sometimes becomes darker than the surrounding skin.

The cuticle, we find from what occurs in common blisters, is very easily restored, as it forms from the whole of the bared surface at once.

The last and most dangerous termination of inflammation is mortification. The terms gangrene and sphacelus have been applied to certain stages of this disposition, but authors have not always agreed in the particular application. To avoid every confusion, it will be better now to mention the state of parts of which these terms are meant to convey the knowledge. By gangrene is understood a state of parts approaching towards real death, but where there is still some property of life remaining. By sphacelus is understood, not an incipient, but an absolute and perfect death of the part. Although gangrene generally precedes sphacelus, this last may happen without the parts affected by it ever having been in a gangrenous state, as from the complete stoppage of the circulation of the blood, or from the actual or potential cautery destroying the life of the part at once.

Inflammation is the more usual cause of mortification, but more particularly the inflammation of the erysipelatous kind. When parts are stimulated to assume and to continue long an action much beyond their strength, mortification is the more usual termination of such action. Mortification is not therefore peculiar to a debility of habit, but may happen in any habit of the body, if the action of a part should be excited much beyond its powers; pressure will sometimes produce it, so will any severe stimulus, if long continued. The symptoms of gangrene are these. The inflammation, which had been very violent, subsides and appears as if going off; the parts which had become swollen and tense, now become soft and flaccid, and upon pressing them with the finger, the impression remains as in œdema; the throbbing ceases although the parts feel very sore when touched; the skin assumes a purple livid appearance, and gradually approaches towards a blackish hue. The cuticle then begins to separate from the cutis, this first shews itself in pustules or rather blisters, filled with a yellowish, reddish, or even blackish liquor; the pulse continues frequent, but its hardness is considerably abated. The surrounding parts often assume the erysipelatous disposition, and then run into the same termination.

When sphacelus or complete death in the part is produced, the symptoms are a total cessation of pain and every kind of feeling when the part is touched or even cut; depression of strength takes place, and this to a very great degree if the mortification is extensive; so much so, that in the strongest man of the most sanguineous temperament, who has laboured under the most violent inflammation attended with hardness, fulness, and frequency of the pulse, and all the most severe symptoms of general inflammatiom, when mortification takes place, these violent symptoms almost immediately cease, and great depression of strength occurs. It sometimes happens that this depression of strength kills.

The cutis now becomes loose and flaccid, and the cuticle is very easily separated from it, and there is often a blackish fluid diffused between them; the parts then become emphysematous, and assume the appearance and smell of putrefaction.

Sometimes the skin of a mortified part becomes hard, dry and black, this generally marks that the mortification is superficial, for when it extends deep, the quantity of fluid contained in it will keep it flaccid and moist.

The sphacelus seems to begin at one or two points, and gradually extends over the neighbouring parts. It sometimes stops of itself; a line is now formed between it and the living parts, and a separating process takes place between them. This separation does not arise from putrefaction; for a limb may mortify gradually from the foot up to the thigh, and the separation will sometimes begin even before the foot has become putrid.

The process of separation is performed by the absorbent vessels. So soon as a part of the body is completely dead, these vessels begin to separate it from the living part, by absorbing those living parts that are in contact with it. Previously to their doing this, there is a determination of blood to the part surrounding the mortification, a degree of inflammation takes place, and a line of suppuration soon becomes perceptible; the absorbents are stimulated by the presence of the dead parts, to remove those living parts in contact with them, and thus the separation is performed by a healthy kind of ulceration.

This separation takes place sooner in parts where the vascularity is considerable, than where it is but small; and sooner near the center of the circulation, than in parts of the body removed from it. When there are strong powers in the system, the sphacelated part is soon thrown off, as in those sloughs which take place in healthy constitutions from accidents, such as burns. When the powers of the part are weakened, as when sphacelus takes place after long continued inflammation, the process will be longer. Mortification sometimes extends so as to destroy the patient without any attempt having been made by nature to stop it, or to throw off the slough.

LECTURE XII.

ON THE TREATMENT OF INFLAMMATION.

My chief view in the arrangement of these lectures, was not to introduce theories built on an imaginary natural or diseased structure of the body, or to recommend practice unwarranted by the test of experience, but rather to demonstrate facts proved by the preparations in the museum of our college, and to accompany these with such remarks as appeared to me best calculated to render them generally useful.

I therefore introduce the following observations on the principles of the treatment of inflammation, not on the supposition that these principles are unknown to my audience, but from feeling it my duty to pass over no subject that will best connect the lectures which I have proposed to deliver; so as to make the whole as intelligible and useful as the materials and my ability will allow, to those who have done me the honour to attend them. I now beg to express my conviction that I could introduce few subjects of which some individual now present might not know as much or more, and reason better on, than myself.

Inflammation arises from a variety of different causes, and is intended to produce a variety of different effects, either in the formation, in the prevention, or in the cure of disease. It is therefore obvious, that the first consideration in the treatment of it should be to ascertain, if possible, the cause from whence it arose; the next, whether it ought to be removed or suffered to proceed? then, in what state of it the removal should be attempted? and lastly, the means by which this can be best effected?

The first of these considerations is of the greatest importance, for when we have ascertained the cause it will in general not prove difficult for us to determine whether the inflammation ought to be removed, or how far it should be suffered to proceed.

It is obvious also, in determining on our mode of treatment, that we should pay attention to the seat of the inflammation, the age and constitution of our patient, and also to what has been the effect of former inflammations, should any have existed. For unless this is done, we may in our attempts to resolve an inflammation entirely counteract the natural cure of a disease, the continuance or re-production of which would tend to destroy the patient. This might happen in many of those inflammations which occasionally take place after fever, peripneumony, palsy, gout affecting the vital parts, and other dangerous diseases; for in such cases inflammation is often a salutary process, and is an attempt of nature to free the constitution from a disease much more dangerous than the inflammation would be, either by continuing or terminating in suppuration. Those inflammations which are likely to form what are called critical abscesses, if they should take place near external parts, or in parts which are not vital, should not have any attempts made, at least without due consideration, to resolve them.

It however may happen that an inflammation succeeding some of these diseases, shall take place in a part essential to life, and in which the formation of matter would in all probability prove fatal; in such a case we can have no doubt, but that the removal of the inflammation while in its adhesive stage should be attempted, and by every possible means, as its continuance, or its termination in suppuration would prove more dangerous, and sometimes more quickly fatal than the disease which nature intended it should cure; thus if seated in the lungs, liver, or any part of equal importance to life, if it is possible to prevent it from suppurating, this should be done from whatever cause it first proceeded.

When inflammation arises for the purpose of removing extraneous or detached substances from the internal parts, whether they were introduced by accident, or were formed or separated from the body, in consequence of disease, we should not resolve it, but should watch over its progress until the intended end was accomplished; nor should we attempt to resolve it entirely in cases of wounds where adhesion cannot immediately take place, or in cases where the injury has deprived parts of the wounded surface of life, for a certain quantity of this action is necessary to the production of granulations and of sloughing. But in any of these cases if the symptoms of inflammation run too high, they may be lessened.

It is very fortunate that by the application of proper means, we have it much in our power to regulate this action; that is, we can often either lessen or increase it, as may be judged the most expedient. We therefore must feel the importance of ascertaining which of the methods of treatment is, in particular cases, the best, as an error at first may prove of very serious consequence. When the cause is once discovered, the mode of treatment is easy to be ascertained; but inflammation sometimes arises without any apparent cause, and when so, our practice must be regulated by taking into consideration all the circumstances we can collect concerning it. In those inflammations, the causes of which are obvious, as when they arise from violence, or some known and peculiar irritation, and where no advantage could be derived from their continuance, the immediate removal is desirable, and should be attempted by resolution, before they exceed the adhesive stage.

If the inflammation proceeds from some irritation which has been discovered; the first step towards resolving it, is the removal of the irritation, and we find in many instances when we accomplish this, that the inflammation subsides, the animal œconomy being naturally averse to the carrying on of diseased action; for here if inflammation continued after the removal of its cause, it would be diseased action. In almost every healthy phlegmonous inflammation, the cause having been removed, the effect ceases in a short time. Thus if inflammation should have been produced by pressure or friction, the substances which occasioned them should be removed. If it should have been produced by any irritating secretion which ought not to have come in contact with the affected part, as when the tears run over the inner angle of the eye, and irritate the cheek in fistula lachrymalis, the inflamed part should be defended from such contact, by covering it with some soft and mild animal or vegetable substance.

Should the secretion possess an irritating property in consequence of some morbid alteration, attempts should be made to return it to its natural state. Thus should the urine contain a greater proportion of salts than usual, so as to irritate and inflame the urethra, the effect of the salts may be prevented by the patient drinking a large quantity of water, for the purpose of diluting them to the degree of a more healthy state. If the secretion cannot be returned to its natural state, or if it should take place from a diseased surface and prove very acrid, the parts which it is likely to come in contact with, should be well defended from it by the mildest expressed oils, or vegetable or animal mucilage. If oils are used for this purpose, such as oil of olives, oil of almonds, or lard, or mutton suet, or spermaceti, or ointments made of these or similar materials, they should be changed or renewed frequently, for when allowed to remain long on an inflamed surface, they become rancid, and will then be likely to produce similar effects to the irritating matter from which they were meant to defend the parts. Mucilages do not grow rancid, but they soon dry, and as many secretions will unite with them they will not always defend the part sufficiently. Mucilages of gum acacia, and infusions of lint or quince seed are often useful applications, and so is the solution of isinglass.

If the inflammation is seated in a moveable part in which motion increases the pain, it is most obvious that the part should be kept at rest.

Not only the cause which first produced the inflammation is to be removed, but also those which are concerned in keeping it up; these last are on some occasions the only causes we can be acquainted with.

In cases of inflammation, in which there appears to be great distention of the vessels, and from the structure of the parts great resistance made to that distention, warmth joined with moisture will frequently have the effect of removing the tension, and should be had recourse to when that tension appears to be the cause of keeping up the inflammation. Thus water heated to the temperature of the body may be applied; but is more efficacious when applied as steam or fomentation. In this form it may be applied singly, or mixed with some emollient and relaxant medicinal substance. When fomentations are intended to have only relaxant effects, their heat should be very little greater than the standard heat of the body, for we find often, that when it is carried to such a degree that the sensation of it becomes uneasy, instead of relaxing, it excites increased action in the inflamed parts.

Pure expressed oils, or these oils mixed with spirits, have been found in some instances to have considerable relaxant effects, and are therefore occasionally employed to remove tension.

These applications tending only to lessen tension, will act no further in the removal of inflammation, than as its continuance depends on that cause. Poultices may be applied more constantly than fomentations, and their operation is similar, in taking off tension, while they also keep the parts easy, and of uniform and proper temperature. Poultices may be used merely as vehicles of applying moisture and warmth, or may be made the vehicles of applying some substances having medicated properties. In common cases of inflammation, where the Surgeon means only to remove tension, to keep the parts easy, and to allow nature to perform the cure, poultices are as good applications as he can employ; but in cases where more must be attempted, other substances may be mixed with them, as opium, preparations of lead, bark or mercury.

The tension may also be removed by emptying the vessels of some of their blood; the application of leeches to the part, or cupping and scarifying will effect this. When a vessel in an inflamed part or its immediate vicinity is opened, the blood will flow more freely into that vessel and through the opening than into or through the neighbouring vessels; thus the general action of the heart and arteries may be diminished in proportion to the quantity of blood evacuated, and the distention and action of the vessels of the part may be lessened in a greater degree, and by the loss of a much smaller quantity of blood, than could have been effected by general bleeding.

The pain which is produced in a part by inflammation, although at first a consequence of that action, may at last become the cause of keeping it up. Poultices are useful in the removal of pain, in so far as they take off tension; but when there is much irritability blended with pain, opium or other medicated substances may be joined to them.

When there is much action and great irritability in a part, and when this irritability appears to be the principal cause of keeping up the inflammation, it sometimes may be removed, and the action of the parts diminished by certain external applications, among which, cold, lead, opium and bark, are the most frequently resorted to. Much caution is however requisite, in determining which of these should be employed, and the extent to which they should be used in different constitutions.

Cold, if used to a certain extent, is one of the greatest sedatives with which we are acquainted; it therefore has been supposed to be a very proper application to an inflamed surface, or to one which has too much action; but very different effects are produced by the degrees of it, and the duration of its application. If a certain degree of cold is applied suddenly, it produces only a temporary contraction of the vessels belonging to the part, and when the first effect has ceased, it excites a greater degree of action than before the application, which action is neither too great at first, nor continued too long, so as to weaken; (we have an example of this in the glow which is felt after the cold bath) on the contrary, by becoming a suitable occasional exercise to the vascular system, it increases its strength.

But if cold is applied to a more intense degree, and continued for a greater length of time, it occasions an effort to be made by the blood vessels to resist its sedative effects, and this action is excited beyond the power which the parts possess of supporting it for any length of time; it is therefore, not an action of strength, but an action of irritability, and, if long continued, will produce indolence in the parts, and not unfrequently mortification. The degree therefore of cold, if not properly proportioned, both in the quantity, and time of application, may produce worse consequences than the inflammation would by continuing. The quantity to be applied, is that which will produce a temporary, not a permanent weakness.

Preparations of lead have been often found to produce very powerful and immediate effects in diminishing the increased action of the vessels, and pain in inflammation; but lead not only lessens the action of the part to which it is applied, but also permanently weakens its powers, and those of the body generally, when used in certain constitutions in any great strength, or continued for any great length of time. The absorption of it into the system, is well known to produce the most violent colics, and partial and general paralysis. Cold and lead may in many cases of inflammation be rendered very useful; but considerable caution is required in their application, particularly in habits naturally very irritable, as in such habits they will often increase the general irritability. They are more certainly useful, when the constitution of the patient is strong and good, as they may then remove the increased sensibility and irritability of a part, without affecting the general system.

Opium is found useful, when applied to inflammations, arising in irritable habits, and also in those cases where there is much pain; it has many of the good, and few of the bad effects of the two former applications. When used as an external application, for the purpose of diminishing the increased action of a part, experience has proved it to be more efficacious when freely, than when sparingly administered.

Alkohol has considerable sedative powers, so have many of the different acids, these may be used with good effect when diluted. Many other substances having sedative qualities, have been used occasionally, and with advantage.

Local inflammation may also have its resolution greatly assisted, by increasing the circulation, and producing inflammation in another part of the body; but which from being external, we can better manage. Thus stimulants, rubefacients, and blisters, are often useful by being applied, and producing a derivation to the skin near the affected part.

Inflammation may also be resolved by taking away the increased action and tension of the vessels of the inflamed part, by diminishing the quantity of blood in circulation; and thus by weakening the whole body, proportionably weakening the action of the affected part. Thus bleeding from the arm may be useful, in addition to local bleeding.

In this mode of cure we find it necessary to proceed with caution, as the quantity of blood to be taken away, and the manner in which it is to be taken, must depend greatly upon the extent and seat of the inflammation, and the particular constitution of the patient.

Bleeding from the system generally, as well as bleeding from the inflamed part, will be found materially useful, when there are very considerable powers of action in the body, and the inflammation is extensive, or has affected a vital part. In these cases we generally find, that more effect in lessening the inflammatory symptoms is produced by evacuating a tolerable quantity of blood suddenly from a large vein, than by a larger quantity taken away at different times, or drawn through a very small orifice in a lesser vein. When the inflammation of the part is likely to terminate fatally, should it not be suddenly removed, bleeding ad deliquium may in some instances be necessary. And as it is temporary, not permanent weakness, which we wish to produce in these cases; it is proper to recollect that this temporary weakness will take place sooner, and by the loss of a less quantity of blood, if the blood is removed from the patient when in an erect posture.

In cases of inflammation when there is too much action in the part, but when the natural powers of the part or system are known to be weak, as when inflammation takes place in parts at a considerable distance from the heart, or in very irritable habits, or in people of an advanced age, it is in most instances best to have recourse at first to topical bleeding; as by these means the constitution will be less permanently weakened.

The quantity of blood to be taken from the system in cases of inflammation must not always be proportioned to the sizy appearance of the blood. When the pulse is quick and hard, there is generally sizy blood; but if we were to bleed in every pulse of this kind, we should often do considerable mischief, as it is a pulse not unusually met with in very irritable habits.

When the pulse is frequent, hard, and strong, with considerable powers in the system and parts, bleeding is commonly necessary. But when the pulse is small, frequent, and hard, and there is great action with little real power, we must be very cautious as to the quantity of blood we remove; a small quantity only should be taken away, sufficient to lessen the present increased action.

When the inflammation is external, we can easily regulate the quantity of blood to be taken away, by the pulse, and by our knowledge of the seat and extent of the action; but when inflammation has seized upon an internal or a vital part, we are obliged to depend more upon the pulse alone. We should therefore in such instances, take away a small quantity of blood at first, and then proceed.as we find this to answer.

The strength of the patient, and the state of the pulse after the first bleeding will in some cases immediately determine, whether more blood can be taken away with advantage; for it occasionally happens in violent inflammations of important parts, that the pulse shall be small and frequent before bleeding, and shall rise and become fuller after it. When so, we have ascertained that the bleeding was useful, and are encouraged to repeat it.

The situation of the inflamed part also makes some difference in the quantity of blood which it may be proper to take away; in inflammation of the brain, bleeding ad deliquium may be necessary; but this would not be necessary in inflammation of the foot.

The state of the urine may sometimes assist us in determining whether we should bleed or not. If it is high coloured and in small quantity, we may generally consider it as an indication to bleed; but if it is pale and secreted in large quantity, we should bleed with caution.

In all cases of inflammation, much attention should be paid to the patient's food. The food should always be of light nourishment and easy digestion. It stands to reason, that whatever heats or increases the force of the circulation should be avoided, as all high meats, wine, shell fish, or spices. In strong constitutions labouring under violent inflammation, very little food need be given.

Purgative medicines answer best in those cases where bleeding is required, but are not to be so much depended on as bleeding. In irritable habits, like bleeding, they should be used with caution; but costiveness must in every case of inflammation be prevented. In common cases, purges composed of the neutral salts, rhubarb, or ol. ricini, answer on the whole better than the drastic purges; but there are cases in strong habits, where purges of calomel, senna, aloes, jalap, colocynth, &c. may be necessary.

Such medicines taken into the stomach as will produce nausea without vomiting, are found to be the most useful, for these medicines for the time tend to lessen, or at least to depress the living powers; but when given to the extent of producing vomiting, they rouse the system to a greater degree of action, and by so doing, sometimes produce the termination of the inflammation in suppuration.

When an inflamed part is intended to suppurate, the extent of the suppuration may be lessened by the regulated use of those means, which are found to be successful in lessening inflammation generally.

Should there be too little action in the inflamed part to produce the termination wished for, it is easy to strengthen the action of the vessels generally, by the use of bark, wine, opium, and cardiac medicines, and to increase the action of the vessels of the part by the application of stimulating substances, such as cummin seed, mustard seed, sabine leaves, or garlic.

In this short account of the treatment of inflammation, you will perceive that I have confined myself to general principles. In these lectures, and before such an audience, it was never my intention to dwell on the treatment of any particular case.

In the affection termed erysipelas, there is so much difference in many particular circumstances from what we meet with in phlegmon, that I feel justified in alluding to some of the most remarkable differences here. One marked difference between phlegmonous and erysipelatous inflammation is, that the latter is always a diseased action.

In erysipelas, we have not a tumour arising to a point, and ending almost imperceptibly as in phlegmon, but the affection is diffused, equal, and in general has a determined boundary or edge. The colour of the affected part is not of the bright florid red as in phlegmon, but is darker, and has often something of a yellowish tint superadded to the darker red. If the part is pressed on by the finger, it receives the impression and becomes pale for a moment or two; but on the pressure being removed it soon returns to its former state and colour. The skin of the affected part has also a hot and dry feel, likewise a kind of puffy feel different from the neighbouring healthy parts, so that in passing the fingers or hand from the one to the other, the skin of the affected part appears to be thicker than the sound skin. The patient has in general a sensation of heat in the part; it is not very painful to the touch, but there is an uneasy sore sensation in it, although not that acute pain which takes place in phlegmon. There is no hardness, tension, or throbbing in the part. Although a larger quantity of blood than usual is contained in the vessels of the part, yet in erysipelas the force of the contraction of the arteries does not appear to be increased.

It frequently spreads very rapidly for a considerable extent, and when it does so is accompanied with a feverish heat and thirst, a nausea and inclination to vomit. Shiverings often take place when it first appears, and continue while it is present. There is a degree of restlessness, also a frequent pulse; the pulse however is not hard as it is in phlegmon.

The seat of this diseased action is most frequently in the skin. Not only is the whole substance of the true skin affected by it; but occasionally also the cellular membrane within and in contact with the skin. It occasionally attacks other membranes, such as the peritoneum and pleura, and indeed in some constitutions, wherever inflammation is excited, it partakes of this disposition. The cutis however is much more susceptible of it than any other part. Every part of the surface of the body is liable to be affected by this kind of inflammation; but it occurs the most frequently in the face and neck, and in the upper and lower extremities.

Those parts in which there are only very small arteries, are almost exclusively the parts in which true erysipelas takes place.

It has been divided into a variety of species, but here I mean to speak of it generally.

The erysipelatous inflammation is found most frequently to affect people of a weak habit of body, whose constitutions are irritable. It occurs more frequently also in infants and in old people, than in adults; in women than in men; and in women more often during pregnancy than at any other period. It is more common in the end of summer, or in autumn, than it is in spring or winter, particularly in hospitals. It sometimes arises spontaneously; sometimes after a low or debilitating fever.

It may thus arise from a great degree of irritability in a part, in which there are no great powers or strength of action, without any assignable reason; or it may arise from some accident in an irritable habit. A puncture either with a dirty or clean instrument through a fascia, or tendinous expansion, such as we find in the hand, foot, or scalp, will sometimes produce it in a tolerably good constitution; in cases of this kind, it is generally a secondary inflammation, but not always so. It frequently takes place in the neighbourhood of a gangrenous part, although it had not previously appeared in the part actually gangrenous. Sudden chills, from exposure to cold, during perspiration will produce it; so will substances remaining long indigested in the stomach. It will occasionally arise after the patient has eaten of shell-fish. I have known eels and salmon produce it repeatedly in the same person.

In the milder cases, the inflammation will continue to increase for three, four, or five days, sometimes more, will remain for a short time stationary, and then will gradually diminish and disappear; after which the cuticle will peel off, either in scurfs or large pieces from the cutis which was affected by it. I have seen the inflammation leave the part where it first began, and travel over a large space without extending the size of its surface, which remained as at first, one part getting well as the other was affected, and the cuticle peeling off from every part where it had passed. This is very different from what takes place in phlegmon.

When more violent it may extend its surface very rapidly, without leaving the part where it began; the heat and irritation may remain some time stationary, then pustules will appear attended with little excoriations; after this it will gradually subside, the pustules forming scales which will dry and fall off. It has been known to terminate in a few hours after a plentiful perspiration has taken place, and in other cases, it has extended so much and so rapidly, as in a short time to destroy life without gangrene being formed.

Erysipelatous inflammation never terminates in a good suppuration; the fluid thrown out is of a thin acrid nature, spreading when it reaches the cellular membrane from cell to cell, no proper adhesions forming to confine it; and the parts affected by its contact are apt to become gangrenous. When pus is formed, it is generally in spots where the phlegmonous inflammation has been mixed with the erysipelatous.

The termination of the erysipelatous inflammation in the throwing out of fluid, should for the above reasons be prevented, if possible, by the active employment of all suitable means.

If the formation of fluid cannot be prevented, we should, by producing phlegmonous inflammation, contrive that the fluid formed may be pus, and that adhesions may be formed to prevent its spreading. Incisions should be made cautiously, to evacuate this matter as soon as it is formed.

If there should be any peculiarity in the constitution likely to act as a predisposing cause of this disease, we would of course direct our attention to the removal of it. As irritation frequently produces it both in the part and in the system, any known irritating cause ought therefore to be removed, or if that cannot be done, should at all events be lessened. If it arises in a part in consequence of a wound, soothing applications to the part, with lenient purges or glysters, will often remove it in a little time; and in a naturally good constitution, where the erysipelas arises from local irritability, particularly in cold climates, the removal of a moderate quantity of blood from the arm, may prove useful. Topical bleeding does not answer; on the contrary, the orifices through which the blood is drawn, will sometimes form very troublesome ulcers, and even gangrene will occasionally arise round them.

When erysipelas happens in a weak and irritable constitution a different treatment will be found adviseable; in this case, bleeding and purging should be avoided; but if the patient is costive, clysters should be used. Tonic medicines may be given; and wine, with nourishing food may be proper. In a true phlegmonous inflammation, bark is found to increase the inflammatory symptoms, and this it certainly will do, whenever the inflammation is kept up from distention; but in erysipelatous inflammation, it rarely, if ever, happens that the inflammation is kept up from distention; it most frequently is kept up from great irritability. Bark, therefore, in these cases, acts from destroying the irritability, and thus takes off the cause continuing the erysipelatous action. The applications which answer the best in removing the affection from the parts, are those of a sedative nature, and it will often prove useful to join to them substances of an astringent power; solutions of opium, alkohol, acetous acid, lime water, and vegetable astringents may be used separately, or in combination, according to circumstances. Emollient fomentations and poultices are generally improper, for they, like preparations of lead, appear to lessen the power as well as the action of the part.

When from a mixture of phlegmonous with erysipelatous inflammation, a thin half formed pus is deposited, we should endeavour to excite that quantity of inflammation that will prevent it from being diffused. In this state, bark, sulphuric acid, and other tonics have been administered with advantage. A common poultice, having a solution of opium mixed with it, and occasionally a spirituous fomentation with opium, will here be found useful. Should fluid be deposited, openings at the most convenient or dependant part may be made to evacuate it as soon as possible; but the parts in this state will not always bear extensive cutting, nor will they afterwards bear any irritating application. In the species of the disease styled erysipelas phlegmonoides, which very often attacks the legs of seamen, and is often attended with most alarming consequences from the great quantity of matter effused between the integuments and muscles, Mr. A. Copland Hutchison has found that making several free incisions with the scalpel on the inflamed surface, in a longitudinal direction, as early as possible, and before any secretion of matter had taken place, has been attended with very beneficial effects. This incision he recommends should be carried through the skin, and adipose membrane to the muscles.

In cases of incipient mortification, we should be cautious in giving a prognostic of the event of the disease, for even in apparently healthy constitutions it has sometimes spread so rapidly, that the patient has been destroyed almost before any great danger was apprehended. In forming our opinion, the nature of the part, and circumstances regarding the preceding inflammation are to be considered, so are the age and habit of the patient, and the attending disease, should there be any present. There is less danger in extensive and superficial, than in smaller but deeper seated mortifications. In every extensive and deep mortification, there is a very considerable sinking and failure of the pulse, with depression of strength, and the real danger of the patient may be better ascertained from the extent of these, than from any other circumstances whatever. The patient is occasionally destroyed by the depression of strength, before the vital parts are affected by the disease.

In the treatment of mortification, the cause of it having been removed, the great objects are to support the strength of the patient, and to take off irritation. Bark and opium are the medicines usually had recourse to, and both of them if administered with judgment are useful in diminishing irritability.

When the erysipelatous inflammation surrounds the mortified part, as it is apt to spread rapidly, and to go into the same termination, we should endeavour to remove this disposition even by procuring the phlegmonous action, for by so doing adhesions may form and set bounds to the mortification, and the dead parts may by it be assisted in their separation from the living. Wine and even spices may be had recourse to here as they act quickly. If wine is used, it should be in moderation at first, and in that quantity that will tend to strengthen the constitution generally rather than to produce merely a temporary degree of strength; and in people accustomed to ale or porter, more beneficial effects will often accompany the use of them than of wine.

Spirits and strong cordial medicines should always be used with great caution, because although they increase action, they do not increase the powers of action; little therefore can be gained by them, but much may be lost, for after their temporary effect is gone off, the weakness which is the cause of the mortification will be increased; bark on the contrary, if it produces any alteration in the system, establishes it, or at least does not leave the constitution worse than it found it. Bark in some constitutions possesses great power of diminishing irritability of the system.

Opium is of use in cases of spreading mortification, because it diminishes irritability and lessens the action produced by it, so as to bring the action of the part or system more on a level with its powers. Fomentations moderately warm of decoction of poppies with spirits, and occasionally with the tinctura opii, will often be useful in stopping the disposition for gangrene to spread, where the affected surface is already extensive. No one application can be exclusively recommended in mortification, the Surgeon must use his judgment, and from existing circumstances determine whether an emollient, a stimulating, a fermenting, or an antiseptic poultice, will be required; as in an early state of the disease, the first may be the most useful, and in a later state, one of the others. I do not mean here to treat of particular cases, or to name all the different applications which may be used in the treatment of them.

On this subject it is unnecessary to say more, and to this audience I have perhaps said too much,

LECTURE XIII.

ON HÆMORRHAGE.

It is an old observation, that in the blood is the life of the body, and whatever different opinions may have been entertained respecting the life of this fluid, there can be none with regard to the importance of it, nor can any subject of inquiry prove more interesting to us in a professional view, than what regards the treatment of those cases in which blood is escaping from its vessels, whether they arise from accident or are the inevitable attendants of some of the operations of Surgery. Hæmorrhage in the first instance, from its well known and suddenly fatal termination, often forms one of the most alarming and dangerous cases on which we are required to exercise our professional skill ; in the other, our individual reputation, as well as that of the surgical art generally, and the life of the person confiding in both, are implicated in our knowledge of the immediate and decisive treatment, which the peculiar circumstances of the case may require.

By the term hæmorrhage is meant an effusion of blood from any of its containing vessels, either into internal parts of the body, or on surfaces naturally external, or rendered so by accident, such as cut or torn surfaces.

Hæmorrhages have been divided by nosologists into active and passive. By active, they mean those which happen from some internal cause, and which are generally attended with some degree of fever. Of this kind, are those hæmorrhages which arise from the structure of the exhalant vessels of the skin becoming so altered, as to allow of blood being poured out instead of the usual perspirable matter; or from glands being so altered, as to allow of blood passing through their secreting structure unchanged.

By passive, they mean those which arise from some partial or complete division of the coats of a blood vessel, so as to expose its cavity, or which take place from some internal cause not connected with, or in consequence of an increased impetus of the blood in the vessels throwing it out.

It is only to hæmorrhages arising from an accidental, or intentional division, or morbid destruction of the coats of a blood vessel, that the following observations are intended to be applied.

Hæmorrhages may take place either from arteries or veins, or occasionally from both, as on a cut or diseased surface. In arterial hæmorrhage from every part of the body, excepting the lungs, the blood is constantly of a florid red colour, and unless it comes from the smallest arteries, flows *per saltum*, springing farther at every contraction of the heart. In venous hæmorrhage, the blood is generally of a dark red colour, unless it comes from the pulmonary veins, and either oozes out or flows from the vessel in an equal uninterrupted stream.

From the blood circulating in an artery with more force, and from the artery being in general deeper seated than the corresponding vein, the difficulty in stopping blood flowing from it is greater, consequently, there is more danger in arterial than in venous hæmorrhage. When an artery is divided, the parts which were supplied by it, must be partially or totally deprived of their required quantity of blood if they do not possess other trunks or anastomising vessels; this is not so in the division of a vein.

Venous hæmorrhage however is not without danger, for a large and deep seated vein may be punctured, and the corresponding artery not being injured, the blood may continue to flow even to the destruction of life, from the quantity which may be lost. To be enabled to prevent this fatal termination of hæmorrhage, we must inquire into, and must ascertain what are the other causes of its stoppage; for it may stop from natural causes; may cease from some accidental occurrence, or may be restrained by artificial means,' the knowledge and management of which it is the duty of the Surgeon to be well acquainted with.

ON THE NATURAL STOPPAGE OF HÆMORRHAGE.

It is well known, that when the arteries of any part are completely divided, unless they are of a large size, the bleeding will stop after some time, without any artificial means being used to effect this.

This spontaneous stopping of the bleeding may arise from a single cause, or from the combination of several.

It may, in the first place, arise from the muscular fibres which enter into the composition of an artery contracting so as to obliterate its cavity, and when so, the power of muscular contraction must be greater than the impetus of the circulation of blood in the vessel. In small arteries where the muscular powers are greater than the elastic, and in which, on account of their distance from the heart, the force of the circulation is diminished, this contraction will be sufficient to stop the hæmorrhage, and will be assisted in doing this by the tumefaction which always takes place in the surrounding parts, in consequence of the injury inflicted on them.

The internal surface of an artery being thus brought into and retained in contact, the coagulable lymph thrown out at the time of division, or effused afterwards in consequence of the adhesive inflammation, renders the canal impervious, by firmly uniting the surfaces on which it is thrown.

But in the division of the larger arteries, where the elastic property bears a greater proportion to the muscular, and where the force of the circulation is stronger, this is not sufficient. Muscular contraction will sometimes stop the bleeding at first; but the power of the muscular fibres being less than the impetus of the blood, and this impetus being assisted by the elastic property here endeavouring to distend the artery, it is at last overcome, and the vessel again allows the blood to escape.

Muscular contraction is therefore aided by the disposition which the blood has to coagulate on the outside of the vessel, and in some instances, by its coagulating in the orifice and cavity of the vessel itself; thus the coagula assisting the contraction of the artery, by pressing on its orifice, and also by partially plugging it up, between them the effusion of blood is restrained.

In operations where the blood is immediately removed, the muscular contraction cannot have this assistance, the blood not remaining long enough to coagulate firmly, if it coagulates at all.

From a series of well judged and important experiments, made by Dr. Jones, on the arteries of horses and dogs, it has been very satisfactorily proved, that in the stoppage of hæmorrhage, nature does not depend on the influence of one process, but produces the effect gradually, by the co-operation of several.

Thus, when an artery of a moderate size is divided, it immediately retracts within the sheath formed by the cellular membrane surrounding it and connecting it to other parts; a degree of contraction of its muscular fibres follows; the impetus of the circulation however soon overcomes this, and the blood is then effused into the cellular membrane connecting the artery with the parts surrounding it; this cellular membrane obstructing and entangling the blood as it flows, lays the foundation for a coagulum to form, which is gradually enlarged until it presses on the orifice of the vessel; the blood now flows slower from the first impetus being diminished by the loss of a certain quantity having produced faintness; in this state of the body it coagulates more quickly, and soon fills up the cavity formed by the retraction of the artery, and presses on the orifice; the blood immediately within the orifice in the artery now being at rest, forms a small conical coagulum extending some way into its cavity, which adheres slightly by its circumference to the cut or divided surface only of the wounded vessel.

The length of this internal coagulum depends on the distance between the divided part of the artery and any large collateral branch. After this, in consequence of the injury, the cut or lacerated extremity of the artery inflames, and then coagulable lymph is poured out by its vasa vasorum, so as to fill up the space between the external coagulum and that which forms the plug in the cavity of the artery; the coagulable lymph adheres to both in becoming solid, and also firmly to the inner surface of the artery.

The artery, as the coagulum forms, gradually continues to contract; from the inflammation which comes on, coagulable lymph is poured out between its coats, and into the cellular membrane surrounding the injured part, so that these parts become thickened and much blended together; and in some instances, where the external wound does not heal, the coagulable lymph shall be effused so as to give the artery a covering, excluding it completely from the exposed part of the wound. It appears thus, from Dr. Jones's experiments, that when an artery has been completely divided, three coagula are formed, viz. one of the extravasated blood externally; one of the blood in the cavity of the vessel, and a third of coagulable lymph thrown out from the vessels of the artery, which adheres to its sides, and also to the other coagula, sometimes joining them together.

In the complete division of an artery, the internal coagulum adheres to the artery only at its circumference in immediate contact with the divided part, that which extends into the cavity of the vessel does not adhere to its side; but if the internal coat of the artery has been lacerated from being stretched or bruised, lymph will be thrown out from the injured parts, which will form adhesions, so far as each of them extends, between the inner surface of the artery and the circumference of the coagulum.

This coagulum is not only found in the cavities of divided arteries, but is also met with in those vessels which connected the uterus to the placenta in women who have died soon after delivery; it is found in the cavities, and even in the orifices formed by the rupture of some of the blood vessels in the lungs, where the patient has died from the effects of the hæmorrhage, although the flow of blood had been stopped by this process some hours, or even days before death. In abscesses of the lungs, liver, or any other very vascular part, fatal hæmorrhage is prevented by the larger blood vessels having been rendered impervious, by coagulable lymph filling up their cavities. And in mortification of the extremities, we find that nature by this means prevents death occurring from the loss of blood when the slough separates.

Monsieur Petit is generally supposed to be the first who discovered the use of this coagulum in the stoppage of blood flowing from ruptured or divided vessels, and he is entitled to a very high degree of praise for his experiments and communications on this and other subjects connected with hæmorrhage; but whoever will peruse the works of that extraordinary man, Albucasis the Arabian, will find, that he was well acquainted with the coagulation of blood being one of the means of the stoppage of hæmorrhage.

The translator of his works into Latin, makes him express himself in these words:

"Arctè quam primum digitis suis comprimat "arteriæ orificium, et constringat eam valde donec "obsessus sit sanguis, et digitus non removeatur, "effundatque celeriter aquam maxime frigidam, "donec congeletur, et ingrossetur sanguis."

When an artery is punctured or partially divided, blood is poured in considerable quantity into the sheath formed by the cellular membrane surrounding the vessel, and soon coagulates there, the distension of the sheath occasions an alteration in the relative situation of the puncture in it and the puncture in the artery, so that the two are no longer directly in the same line, but rather disposed in a valvular manner; this effect confines the blood when it coagulates so as to make it pass immediately over the wound in the artery, and thus assists in preventing a farther effusion, until such time as the flow of blood is permanently suppressed, by the process of healing or obliteration which takes place in the wounded artery. From this process it has sometimes happened, that a wound of the brachial artery has healed, and no future disease has followed; but cases of this nature occur very rarely, for the continual systole and diastole of the artery prevent the rest necessary to effect a firm union. Dr. Jones, however, in experiments on quadrupeds, found that arteries, if wounded only to a moderate extent, were capable of re-uniting and healing so completely, that after a certain time no mark of their ever having been wounded could be discovered; the wound being longitudinal, oblique or transverse made much difference in the probability of this happening; a transverse wound being attended with a great retraction of the divided surfaces, while one that was longitudinal produced only the slightest separation. This is not exactly what would be expected, as the circular packets of muscular fibres are strongly marked, and the longitudinal ones are not perceptible.

The accidental stoppage of hæmorrhage may happen from the manner in which the arteries are divided. When they are forcibly torn asunder, no great bleeding takes place; for the cavities may be much diminished, or even obliterated from the vessel being so much over stretched or elongated previous to its giving way.

This not only happens in the smaller branches, but also in the larger trunks, as in the case of Wood the Miller, familiar to us all, as related by Cheselden. I witnessed many years ago at Brighton a similar occurrence, where the Gunner's arm was blown from his body in consequence of some fire being retained in a cannon which had been just discharged, and which ignited the second cartridge while the man was employed in ramming it into the gun; not one drop of blood escaped from the axillary artery.

Brute animals from instinct nibble off the navel strings of their young, and from this mode of division, no hæmorrhage takes place. Those men whose business it is to castrate horses, calves, pigs, and other animals, probably copying from this, draw out the spermatic chord, stretch it considerably, and then divide it with a blunt knife.

When nature is insufficient to the stoppage of hæmorrhage, or when it has continued, or is likely to continue so long as to be productive of danger, the Surgeon then must have recourse to the artificial means of stopping it, either by the application of substances called styptics, or by securing the vessel by means of a ligature.

A great variety of different substances have been at times recommended as styptics, and these have been supposed to act by various qualities. They were favourite applications of the older Surgeons, and this need not surprise us, when we recollect, that formerly, no certain means were known of stopping hæmorrhage, excepting by the application of burning iron. Styptics are now more limited in number and in use, since means have been discovered, which have proved more certain and less painful in stopping the bleeding of the larger vessels, viz. the application of ligatures.

From the statements of the efficacy and certainty of the success of some styptics, which have been transmitted to us by their particular discoverers or admirers, we might at first wonder why so painful a method, as the application of a ligature, should ever have been had recourse to.

Experience, however, our surest guide, does not confirm the statements thus confidently made. It is not meant to be asserted, that many of the cases which are recorded of hæmorrhages stopping during the application of styptics are not founded in fact; but it is far from improbable, that in many of them, the cause has been mistaken, and that the natural stoppage of the hæmorrhage has been attributed falsely, but perhaps undesignedly to the effects of styptics. Hæmorrhages from arteries larger than have generally been imagined will stop spontaneously, particularly if the division of the vessels has been complete. In many brute animals, no very alarming symptoms have arisen from the amputation of the leg. This has been tried on dogs and lesser animals, and it has rarely happened that they have died from bleeding although neither ligature or styptic applications of any kind have been used. John Hunter cut off the limb of a boar some way above the knee joint, and no very great quantity of blood was lost. Even in men, instances are not wanting of arteries of a considerable size having been divided, without death being produced, although no artificial means were used to stop the bleeding. It is well known that when the temporal artery has been intentionally divided, it often becomes difficult to get away the wished for quantity of blood from it.

It would however be too hazardous to conclude from the analogy of brutes, that a man might have his leg amputated below the knee, without dying of hæmorrhage should no ligatures be used; but it is certainly allowable from analogy, to conclude, that the stoppage of the bleeding by nature may, in many cases, have been attributed to the effects of styptics, the more especially, as these cases are related as having happened in vessels, which in brute animals have been divided without much risk, and never as having taken place in the femoral or larger arteries. In stating these circumstances, the only object is to prevent too much credit from being given to the imaginary effects of certain styptics, so as to endanger the loss of a patient's life, when we have it in our power to employ much safer and more certain means for stopping the flow of blood.

Styptics are supposed to act in three ways; by disposing the vessel to contract; by disposing the blood to coagulate; and by destroying the life of the vessel.

The first of these, if it proved effectual, would undoubtedly be the best, as its action approaches nearest to the simplest method which nature uses in stopping hæmorrhage. It is not only necessary that the vessel should contract, but should contract strongly; many of these styptics have, therefore, a considerable stimulating quality. They prove the most effectual when applied to small arteries, as in these the power of muscular contraction is greater than in the larger, they are consequently more susceptible of the stimulus. Among this class may be reckoned infusion of galls, and of oak bark, astringent gums, alum, spirits of turpentine, and many other substances.

Cold, though ultimately a powerful sedative, has on its first application the effect of exciting muscular fibres to contraction, and therefore is sometimes useful. Cold water, vinegar and water, and also ice may on this principle be occasionally employed with advantage.

Those styptics which dispose the blood to coagulate, are the most useful when the bleeding is from a surface, or from small vessels where the blood is flowing slowly. They are supposed to act by absorbing the thinner parts of the blood, and thus allowing a coagulum to form firmer and sooner than it would otherwise have done. In this class may be enumerated almost every mild absorbent substance, as flour, lint, down of hats, cobwebs, sponge, fungous substances as the lycoperdon vulgare and the agaricus quercus. This last was at one time much celebrated. M. Broissard in the year 1750, even received a considerable sum of money from the French King for the discovery of it. This being communicated to the Royal Society of London, Mr. Warner of Guy's Hospital, at the desire of the Society, gave it many fair trials, and speaks favourably of its qualities; but its novelty is now passed; and it is not more frequently used, nor is it found to have more effect in the stoppage of hæmorrhage, than other fungous substances.

The liquor plumbi acetatis is a good coagulant, as it coagulates almost all animal and vegetable mucilages, and has therefore been sometimes used with advantage as a styptic.

The third class cannot with propriety be called styptics, as they produce their effect by destroying the life of the vessels, and forming an eschar on the bleeding mouths. They are more powerful and certain, however, than any of the substances belonging to the preceding classes, and were at first the only applications resorted to, in stopping the bleeding of large vessels; belonging to this class are, the sulphas cupri, concentrated acids, boiling oil of turpentine, caustic applications of all kinds, and the actual cautery.

When a bleeding vessel is so situated, that it cannot have a ligature passed round it, or be otherwise compressed, heat is the moft powerful method which can be used to stop the hæmorrhage. It should not be had recourse to, however, where other methods can be practised. Much inconvenience, pain, and danger attend the use of it, for although it will immediately stop the bleeding, when applied to a large vessel, great risk is afterwards incurred of the eschar being detached too soon. This will generally happen, if the heat applied has been too great; for by this heat the parts will be reduced to a cinder, when they ought only to have their living principle destroyed. When it is absolutely necessary to use the actual cautery, the iron should be made to approach only to a reddish heat, and should be as thick as can be conveniently admitted; a thin or small iron loosing its heat very quickly. Before the eschar falls off, we should use some precaution to prevent or stop a fresh hæmorrhage, which might take place at that time.

Although many of these styptic applications may be tried, and probably with some advantage under particular circumstances, the general use of them is not to be recommended, for they cannot safely be depended on in the bleeding of the larger arteries. In such arteries the hæmorrhage should be stopped by actual compression.

The application of the tourniquet to the trunk of the artery, so as to close its cavity between the bleeding orifice and the heart, is one mode of compression; but it is a mode only employed temporarily, to afford sufficient time for the application of ligatures.

Compression by ligature may be performed in two ways; either by passing a needle with a ligature round the bleeding artery, and including in the compressure some of the neighbouring surrounding parts; or by drawing the artery out of its sheath by the tenaculum, and passing the ligature round it alone.

Each of these modes has been exclusively recommended and practised by certain Surgeons, who have also in general strongly reprobated the mode not adopted by them.

I shall not here enter into all the arguments which have been used on either side, but content myself with saying, that neither method is to be recommended, or reprobated exclusively; for each, under different circumstances, will prove the best.

No one, I believe, now doubts (should the patient not be greatly advanced in years, the artery be sound, and its situation admit the attempt to be made,) but that a ligature applied to it alone, is the mode from which the greatest advantages and fewest disadvantages will arise; and this plan is therefore, in general, much to be preferred. But should the artery be diseased, and in old age it generally is so, being more or less ossified, and in cases where it cannot without great difficulty be got at, so as to be drawn out by the tenaculum, the needle will prove the safest method. It includes in the ligature more than the vessel; but under the above mentioned circumstances, this will not prove so injurious as it may be advantageous. In old people, it may produce more of the adhesive inflammation, and thus eventually make the extremity of the artery stronger. In cases in which the needle is used, where the nerve can be separated, this should always be done.

The degree of force used in tying the ligature carried round the artery by the needle, must be proportioned to the quantity of soft parts included in it, as well as to the thickness and firmness of the artery; it should be sufficient to keep the inner surface of the artery in perfect contact, and perhaps a little more than this; but if too much force is used, some parts are immediately divided, and others go quickly into ulceration, before adhesion can be accomplished, so that the patient is endangered by a secondary hæmorrhage.

To judge properly of the force to be employed when we apply the ligature to the bare artery, using the tenaculum to draw it out for that purpose, we must understand the process which usually takes place in the stoppage of the hæmorrhage by this method.

It had been observed first by M. Dessault, that when a ligature was applied immediately to the coats of an artery, the internal and generally the middle or muscular coat were divided. Mr. J. Thompson of Edinburgh communicated this circumstance to Dr. Jones, who was at that time engaged in making his experiments on arteries; Dr. Jones immediately instituted a series of experiments to prove or disprove the fact, and the result was, that the first effect of the ligature besides closing the canal of the artery, was a division of the internal and muscular coats; the wounded surface all round was kept in apposition, and the circulation of the blood completely stopped. The vasa vasorum of the artery then began the action of inflammation, coagulable lymph was thrown out on the wounded surface, which being kept in contact by the ligature soon united all round, the same process taking place as in simple incised wounds when united by the first intention; coagulable lymph was also effused above and below the ligature into the coats of the artery, and into the cellular membrane of the surrounding parts; the blood being at rest above the ligature, formed a coagulum, which generally extended to the nearest anastomosing branches. After the union of the inner circumference of the artery had been thus effected, the ligature, acting as an extraneous substance, produced the absorption of the compressed part, which absorption went through the newly formed impervious portion, and the ligature then came away; granulations took place from the divided surfaces, and united with each other, while the thickened cellular membrane also adhered to them. A plug of solid coagulable lymph is found in the cavity of the artery above and below the ligature, and the canal after a time becomes impervious from that part to the anastomosing branches, which are enlarged to convey blood to the parts beyond the obstruction.

When a ligature, by means of a tenaculum or other instrument, has been applied to a divided artery; the same circumstances occur above the ligature; but the part below it sloughs, and generally comes away when the ligature has been detached.

In the application of a ligature to a divided artery, we therefore should adapt the form of the ligature, and proportion the force we use in tying it, to the effect meant to be produced.

The ligature should be of a regular thickness, and of a round shape, as it will then produce a more equal pressure, so as to make the division of the internal coat of the artery more to resemble a clean and simple incised wound, and therefore one which will be more likely to unite by the first intention, than one in which the parts are irregularly divided or much bruised.

Care should be taken that the ligature be applied so as not to form an oval, by one part being higher than another; it should be applied as circularly as possible round the artery, the parts which are to unite will then be in the most perfect apposition. The ligature should be sufficiently tightened, so as not only to keep the inner surface of the artery in contact, but also to produce the regular division of the inner coat, but not so as either to endanger the immediate division, or too early ulceration of the external coat. This force must be determined by the judgment and experience of the Surgeon. It must vary according to the size and strength of the artery, nor is it possible in words to convey an adequate idea of it, more than by saying, that the force used must be something exceeding that which is necessary merely to keep the artery impervious to blood flowing towards the part. If this is properly attended to, there will be but little risk of the force of the circulation detaching the ligature.

In every case where danger might be apprehended from a secondary hæmorrhage, all kind of motion in the part should be prohibited, so should every exertion, either of body or mind, that would tend to increase the force of the circulation generally. If medicines are given, they should be those which are of a cooling or refrigerant nature; diluted acids, particularly the vegetable and sulphuric acids are often useful. The patient should be kept on low spare diet. Wine, spirits and cordials of every kind should be prohibited, until we have reason to think that the adhesion of the inner surface of the artery is secured.

In cases of hæmorrhage from vessels so situated that a ligature cannot be applied, it sometimes has been found useful to take blood from a vein suddenly, and by a large orifice, so as to produce fainting as soon as possible.

Langour and fainting dispose the blood to coagulate quickly, and, therefore in long continued hæmorrhages which we cannot stop, should be encouraged rather than prevented. Fainting appears indeed to be the way which nature generally takes to stop hæmorrhage. Unless a very large artery is divided or punctured, a patient rarely dies of hæmorrhage, but gradually becomes weaker and weaker, and at last faints, when the bleeding ceases of itself.

When these faintings happen in cases where no ligature can be applied, and where a second bleeding would prove highly dangerous, we should carefully avoid using, or permitting to be used, the common methods of bringing people out of fainting fits, such as the internal use and external application of stimulants and cordials; for these would greatly tend to re-produce the bleeding. The patient should be left at rest and in a cool room, and when recovered from the faintness, the lightest aliment should be given occasionally so as merely to support life.

During the fainting, the force of the circulation is much lessened, and the blood disposed to coagulate immediately, so that it coagulates on and sometimes in the orifice of the bleeding vessel. Dr. Hunter carried his ideas of the efficacy of the above mentioned treatment so far as to say, in almost every case of internal hæmorrhage nothing more need be done than to allow the patient to faint, and life would be preserved.

In addition to the diluted vegetable and sulphuric acids, nitre, the plumbi superacetas, and oleum terebinthinæ, may, if given with care, sometimes be useful. So may opium, but I think only when given in sufficiently powerful doses, so as to produce faintness.

Blood is often effused from a ruptured vessel into the cells of the cellular membrane, where it coagulates and forms a tumour; in this case we should not make incisions and use force to remove it, for it is generally soon absorbed. Moderate pressure, friction and stimulating lotions may be applied to quicken the absorption after the first chance of inflammation is over. A large quantity of blood is sometimes extravasated without any wound in the skin having taken place, and which remains without coagulating. It is in general the best practice to let it remain, as it is often absorbed. Although it may sometimes be let out by a small opening, and the sides of the cavity afterwards unite, yet it frequently happens that suppuration of the whole cavity follows the opening. Should suppurations take place in cases where blood is extravasated, they should be treated like other abscesses; when the abscesses open, poultices should be applied, and the coagulated blood allowed to be thurst out by the contraction natural to the part.

When a small artery is punctured and bleeds much, and we cannot stop it by compression we often find, that by dividing it completely, so as to allow it to retract and contract, the hæmorrhage will soon cease.

When an artery is divided and has retracted within a bony canal, its adhesion to the inner surface of such canal may prevent it from contracting, and great danger, even loss of life, may thus arise from the bleeding of a very small artery, the flow of blood from it being constant, but too slow to produce fainting; I have known the small artery belonging to a single tooth, bleed so as to endanger the loss of life; in cases of this nature, if compresses of spunge or other materials do not answer, the potential or actual cautery must be used.

In punctured wounds of fleshy parts, where a deep seated artery has been opened, filling the cavity of the wound leading to the vessel with spunge, has sometimes succeeded in stopping the bleeding.

When the principal artery of a limb is punctured, as when the brachial artery has been wounded by mistake or accident in bleeding, it seldom closes and unites by the first intention, its continual systole and diastole preventing the cut surfaces from remaining long enough in contact. In a case of this kind, as much blood should be evacuated as the patient can with safety bear to lose, as this evacuation must materially lessen the force of the circulation and action of the artery; the edges of the wound should then be brought and retained together by slips of adhesive plaster, and a roller applied so as merely to support, not to form a great compressure on the wounded part, and certainly not so tight as to at all impede the circulation going freely on in the anastomosing branches, or to prevent the free return of the blood by the veins. The patient, and the part particularly should be kept at rest. Lenient purgatives and occasional venesections, with low diet may be necessary to keep the circulation sufficiently under. By these means a chance, at least, is given to the wound in the artery to unite by the first intention. Should this treatment not succeed, but the blood still continue to flow, we then should cut down upon the artery and apply ligatures, one above and the other below the wound. The anastomosing branches we are assured will always convey a proper quantity of blood to support the parts below the ligature.

When hæmorrhage takes place from the intercostal or epigastic arteries, in applying the ligatures we should be careful to prevent them from entering the cavities of the thorax or abdomen, as they would then act as setons. But it is unnecessary to state to the persons who compose this audience how particular cases of hæmorrhage are to be treated, I have therefore to apologize even for the little I have said, as their own knowledge and experience will inform them where to apply general principles, and where to adopt a peculiar, but perhaps an improved mode of practice.

LECTURE XIV.

ON ANEURISM.

An aneurism is a tumour formed by a morbid dilatation or rupture of the heart, or any part of the arterial system, containing blood, either fluid or coagulated, but generally a mixture of both. It is on those aneurisms which affect the arterial system, that the following observations are intended to be made.

Aneurisms have been divided into several species, but all may be comprehended under the following classes, viz. the true, the spurious, and the varicose.

In the true aneurism, at the beginning of the disease the coats of the artery are not ruptured, on the contrary they are often increased in thickness before they become morbidly dilated; and in general the alteration in structure appears to begin in the inner and muscular coats.

Aneurisms sometimes take place in several arteries of the same body forming distinct tumours. In other instances, the whole of the aorta and the principal branches proceeding from it shall be enlarged, and their coats diseased without any one part projecting more than the rest. By some pathological writers, this general enlargement has been considered as a disease distinct from aneurism; to me it appears only a variety of the same affection. Sometimes the disease is confined to a particular part of a single artery.

This disease appears to arise from the circulation of the blood being carried on with greater force than the artery has powers of resistance; or in other words, from a disproportion between the force used in circulating the blood and the strength of the artery; for if a due proportion constantly existed between them, it is evident that an aneurismal swelling never could arise. But should any part of an artery become weakened, the force of the heart on the blood continuing unabated, the weak part cannot resist the momentum; it therefore gradually yields to it and becomes dilated. In proportion as it dilates, its powers of resistance become diminished, and the force of the heart continuing the same, it necessarily follows that a further increase of the tumour must ensue. This will apply not only to one morbid swelling, but also to a variety of aneurisms arising at the same time in different arteries of the same body.

When there is a general morbid disposition in the whole of the larger arterial trunks, the force of the heart not being diminished, the upper part of the arch of the aorta will be the most likely to enlarge first, as it is opposed to and immediately receives the whole impetus with which the blood is ejected from the heart by the contraction of the ventricle. In the rest of the aorta this impetus must be much less, on account of the greater distance from the heart also from the loss of the usual assistance added to it by the action of the artery, in consequence of the muscularity and elasticity of its diseased part being destroyed, and from the dilatation of the vessel through which the blood has to pass, necessarily altering the velocity of the current. But should there be a greater disposition to disease in one part than in another, this disposition may counter balance the advantages which the part derives from situation.

Concerning the remote and predisposing causes of true aneurism, a variety of opinions have been entertained. Whatever can prevent the blood from circulating freely in the arteries, has been mentioned as a cause; and this whether partial or general. Partial, as any tumour pressing on an artery so as to occasion a stagnation of blood in it, or to occasion it to act with greater force than usual, and thus to weaken it by obliging it to exert its power beyond its strength. General, when from ossifications, polypi, diseased lungs or other causes, much difficulty is incurred in passing the blood from the arteries into the veins, and consequently an accumulation of it in the whole arterial system may be supposed to take place. (It may be much doubted whether this last named general cause would produce aneurism.)

Lancisi and some others have remarked, that this disease happens frequently in gluttons and drunkards. No perfectly satisfactory reason can be given why aneurism should originate more frequently in this class of men than in many others; but having once begun, it is likely in them to make a rapid progress, from their habit being in general plethoric, and their circulation being very frequently much accelerated.

Morgagni and some of his correspondents have stated, that coachmen and post boys are very subject to this disease. I have known several instances of popliteal aneurism taking place in men of this description, and if it does frequently take place in free livers, as many of these men drink to excess, the same cause may produce it in them; and from the position of the hams in riding, the artery then forming an angle, and not receiving support from surrounding parts, may become there more disposed to assume the disease.

Aneurisms happen the most frequently in people advanced in life. This has been accounted for on the supposition, that in such people the elastic power of the arteries is nearly worn out, while the force of the heart is not in the same proportion lessened.

In old people a disease often arises in the coats of arteries, producing a disproportion between their strength and the force of the heart. This disease consists in small ossifications rendering the coats of the artery thicker at one place than another, depriving the internal surface of its smoothness, and destroying elasticity. People in the early part of life are not very subject to these calcareous depositions, but I have occasionally met with them in the arteries of very young people. I have seen a well marked deposition of the phosphate of lime in the arteries of a child under three years of age. These depositions might have had great effect in laying the foundation for aneurisms, had the persons lived. It rarely happens, that the arteries of a person who exceeded before death sixty years of age, are found free from these ossifications. This brittle matter is generally deposited at first on the surface of the internal coat next to the muscular.

The deposition appears in the form of opaque spots of various shapes and sizes, which thicken and make the inner coat more prominent towards the cavity of the artery: the surface is at first smooth and tolerably flexible, it afterwards becomes brittle and rough; the disease extends into the muscular coat and sometimes to the external; the internal coat is sometimes abraded so that there is no membrane between the blood and the deposition; sometimes very prominent and rough spicula from it project into the cavity of the artery. The number of preparations of this disease preserved in the museum, shew all the varieties from its first origin to the formation of thin bony scales, and so progressively until the artery for some considerable length appears a tube of bone.

This disease lays the foundation not only for aneurism, but also for mortifications of the extremities, and for apoplexy. I have opened the heads of nineteen people of whom I have preserved some account, and of several since who have died of apoplexy, and in all of them I found the arteries forming the circulus arteriosus and branches proceeding from it, to have much phosphate of lime deposited in their coats, and in some few I have traced the effused blood to the rupture of such diseased vessel.

Aneurism is not confined to very old people; I have met with several instances of the disease affecting the aorta and other vessels, in people not exceeding forty years of age.

Women are so seldom affected by it, that it has been doubted, by some, whether it ever takes place in them. I recollect having heard John Hunter observe, a few years before his death, that he had only met with one case of true aneurism in a woman. During that winter I shewed him two cases of the disease affecting the aorta in women, one of whom was then alive, and lived six months afterwards; the other case was in a body brought into the dissecting room, in Windmill Street. I have since that period met with similar cases. If some of the causes which are said to produce aneurism in men are true, women from being less exposed to the action of these causes, are consequently less likely to be affected by it. Mr. Hodgson states that of sixty-three cases in which he had an opportunity of seeing the patients during life, or of examining the parts soon after death, fifty-six were males, and seven females, and none of these were aneurisms which arose from wounded arteries.

Violent efforts, strains, blows and contusions have been considered as causes for the production of aneurism, and the following is a case in point. A young officer at Gibraltar, leaping for joy at the arrival of the ship which was to convey him to England, felt a sudden pain in his groin; no tumour or extravasation of blood immediately followed, the coats of the artery were therefore not torn through; but in six weeks after his arrival in England, an aneurism appeared in the inguinal artery, which ultimately destroyed him. Abscesses in the neighbourhood of large arterial trunks have, it has been said, so weakened the vessels that aneurisms have taken place.

A cause to which the production of aneurism has been very generally attributed, is the partial division or rupture of the coats of an artery. Haller and John Hunter made a variety of experiments on dogs and frogs, to ascertain how far this cause is to be admitted, and the results drawn from their experiments have been directly at variance. Haller asserted that he could when he pleased produce an aneurism in these animals, by separating the muscular coat of their arteries from the internal. Hunter asserted, that by so doing the vessel, from the adhesive inflammation taking place, would become firmer than ever. This difference of opinion in two such eminent men, shews the necessity, before an experiment is admitted to prove any thing, of having every circumstance relative to its performance fully explained. For when we know that Haller did not suffer the surrounding parts to unite, and that John Hunter did, we are no longer at a loss to account for the different conclusions.

The largest arteries are the most likely to be affected with aneurism. It very rarely occurs in smaller arteries. It has frequently occurred in the aorta, carotid, subclavian and axillary arteries, not often in the brachial, and I know of no instance of it happening below the elbow joint which could not be traced to some accidental or intentional division of the coats of the artery. From the division of the coats, an aneurism of the spurious kind may take place in any artery, large or small. True aneurism has not unfrequently occurred in the internal and external iliac arteries, in the inguinal, femoral, and very frequently in the popliteal. It has taken place in the posterior tibial artery, but I know of no instance of it in the anterior tibial or peroneal arteries. It has been said to have been met with in the intercostal arteries; but the cases recorded of it in these arteries are of doubtful authority. Instances have been recorded of aneurisms having been met with in some of the arteries within the cranium: I have never seen such an occurrence; but from the authorities by which such cases have been stated, the fact cannot be doubted. I have met with only one instance of true aneurism affecting any of the branches of the aorta which are distributed to the abdominal viscera. In the year 1809, on inspecting the body of a clergyman in the presence of the late Sir Walter Farquhar, a tumour, very much resembling the heart in colour, shape, and size, appeared to hang down from the under surface of the left lobe of the liver; the lobe itself appeared not more than one sixth part of its usual magnitude. When the tumour was opened and carefully inspected, it appeared to have been formed by the left branch of the hepatic artery having become very much enlarged and aneurismal. It had burst, and the blood which had escaped was found in an imperfect cyst, partly in a fluid, and partly in a coagulated state, forming a large proportion of the tumour. Where the tumour joined the liver, a large cavity was formed in it, which contained a mass of coagulable lymph in a solid state, and about five ounces of a brownish fluid; I could not however trace any communication between the enlarged part of the artery and this cavity, although it appeared very like that of another aneurism. The preparation is preserved in the museum in Windmill Street.

The parts of the arteries most usually affected, must depend upon circumstances that prove more favourable to the production of aneurism in one particular part than in another; such as a part having a greater exposure to the impetus of the current of blood, or having less support from the structures which surround it. Aneurism, therefore, frequently takes place in the arch of the aorta, because where-ever there is a bending or angle in an artery the coats of it must be more exposed to the force with which the blood is circulated; consequently, when weakened, it will be more apt to become dilated at that part. The upper part of the arch of the aorta, supposing the whole artery to be equally weakened, would thus yield the first. Should aneurism not take place there, the next most likely part for the disease to happen, is where the cœliac, superior mesenteric, and emulgent arteries are sent off; at this part, the aorta suddenly diminishes in size, and there are also several angles made, both of which circumstances must expose the coats of the vessel to receive more of the heart's action.

Those arteries which have the least support from the parts surrounding them are more frequently affected by this disease than arteries which are better supported; thus aneurisms happen in the axilla, but much more frequently in the ham. The artery in the ham is the least supported of any belonging to the extremities, for as soon as the artery of the thigh has perforated the great triceps muscle, it receives no immediate support either from bone or muscle, and, excepting where it is in contact with the vein, is completely surrounded by adipose membrane. When weakness once takes place in this artery, the want of support must greatly contribute to bring on the disease, and to quicken the progress of it.

Although the above mentioned parts of the arterial system are, from situation, the most likely to become aneurismal, yet should any other part, from accidental causes, become more weakened or diseased than the rest, in that part aneurism will have a greater chance of taking place. I have known an aneurism arise in that very part of an artery which was the most supported.

The symptoms of aneurism are of two kinds :—

the first, are those which belong to the disease exclusively as aneurism. The second, are those which depend upon its particular situation.

In every aneurism there is a tumour, more or less elevated, which possesses from the first a considerable degree of pulsation. If the tumour is pressed on in its recent state, it yields to the pressure, and gradually subsides; but returns as soon as the pressure is removed. If the tumour is not recent, it will only in part subside by compression; this arises from blood having coagulated in its cavity. There is also some difference in the feel of the pulsation of an artery which has recently become aneurismal, and which contains but little coagulum, and another where the swelling is of longer standing, and which contains a larger quantity. In the first, the stroke will be full and distinct, from the propelled blood being immediately applied to the inner surface of the whole bag, and uniformly distending it. In the other, the stroke will be more obscure and indistinct, also more vibratory, from being communicated and felt through several laminæ of coagulated blood. When the diseased artery is very deep seated, the aneurism may have existed for some time without the tumour and pulsation having been felt; these symptoms however exist from the first, but will sooner be perceptible in proportion as the situation of the aneurism is nearer to the skin.

The symptoms of aneurism which depend upon the particular situation of the disease, will, of course, be various; the variety depending partly upon the size of the tumour and partly upon the functions of the parts compressed by it. Thus, when an aneurism is situated in the thorax, it is attended with great irregularity of the pulse, and difficulty of breathing, particularly upon exercise being used; and if the tumour is at the beginning of the aorta, much pain is usually felt extending from the upper part of the chest down the arms; the pulse at the wrist is generally feeble, as the blood passing through the enlarged cavity of the tumour before it reaches the vessels going to the arm, loses much of the impetus it received from the contraction of the heart, and occasions weakness of the pulse, as well as frequent intermission in the number of its beats.

When the disease is situated in the artery belonging to one of the extremities, it will occasion a loss of some of the functions of that extremity, or at least will prevent them from being so perfectly performed. Numbness and pain will arise from pressure being made on the trunks of the nerves. Œdema will also take place from the absorbents being compressed.

When the tumour first appears externally, the colour of the skin is not much altered, but as the size of it increases, the skin becomes paler, then fretted, and sometimes even dead from the pressure; but this is not peculiar to aneurism, the same occurrences may take place in consequence of the enlargement of any encysted tumour.

The anxiety which the bare supposition of a tumour being aneurismal, must produce in the mind of any patient acquainted with the suddenly fatal termination of such disease; and the relief which the Surgeon may be enabled to bestow by removing that supposition, make it most desirable that every circumstance should be known which may lead to the discrimination between other tumours, and this dreadful malady.

Pulsation in a tumour is generally supposed to be the most distinguishing symptom of aneurism, and therefore is one which often occasions the greatest anxiety. It does not however follow, that all tumours which pulsate are aneurisms. Pulsation of a tumour will often take place without being connected with this disease. Thus any encysted or even solid tumour, situated in the neighbourhood of, or upon a large artery, may have a considerable degree of motion communicated to it from the pulsation of the artery. The thyroid gland, when a bronchocele is formed, occasionally receives a pulsatory motion from the carotid arteries. This has been mistaken for an aneurism; but, if on placing our fingers behind the tumour and drawing it forwards the pulsation then ceases, it cannot be an aneurism. It is not in every case of this kind however that we can place our fingers behind the tumour; still we may distinguish between the diseases by attention to the nature of the pulsation. If it is a tumour placed on or near an artery, and deriving its motion from its situation, the whole of it will move at once, as one body, and without any alteration of size. If it is an aneurism, there will be in every part of the tumour a sensation of dilatation superadded; it will not only move, but it will expand. The discrimination between aneurism and other tumours may occasionally be obtained by attending to another circumstance. Tumours of certain parts, from their situation and connection, may have some other motion communicated to or belonging to them, very different from the appearance of pulsation. A tumour of the thyroid gland, possessing an apparently pulsatory motion from its vicinity to the carotid arteries, will also, from its connection with the larynx, move upwards every time an attempt is made to swallow. Therefore by desiring the patient to swallow a little water, and observing the neck at the instant of swallowing, we may ascertain whether the suspected tumour is aneurismal or not; for if aneurismal, being situated in the carotid artery, it would not ascend with the larynx in this attempt.

An aneurismal tumour will diminish upon compression being used; any other kind of tumour situated on an artery will not. There will of course be some variety in the extent to which an aneurism will diminish from compression, arising from its duration, and the quantity of coagulum in its cavity.

Attention to the history of the origin and progress of the disease, will aid us much in making the proper discrimination between aneurismal and other tumours.

When the morbid dilatation of an artery has actually begun, the progress of it is not so rapid as might at first be expected; for the blood which enters the dilated part, loses of its impetus and velocity in the same proportion as the cavity is enlarged; consequently the impetus of the blood becoming less than it was before the dilatation, the size of the cavity increases but slowly; perhaps it would not increase at all, were not its coats weakened by the dilatation, and from blood having begun to coagulate and collect in the dilated part. The swelling in an aneurism is sometimes tolerably regular, the circular fibres appearing to give way in every direction; but most usually the coats of the artery give way more on one side than on the other; this may arise from one side being more weakened or diseased, being less supported, or being more exposed to the current of blood.

In the arch of the aorta, the swelling will generally be in the greatest circumference or top of the arch, and will project forwards. In the carotid arteries, the tumour will push outwards and forwards. In the axillary arteries, it will project towards the inside of the arms, and downwards. In the aorta descendens it will be forwards, so will it in the iliac, inguinal, and femoral arteries; as the last named artery descends, the tumour will project more inwards, and in the popliteal artery the projection will be backwards. These may be considered as the most usual situations and projections of the tumours; but from some of the circumstances already mentioned they may be different.

When an aneurism has taken place in an artery firmly supported on one side, it sometimes happens that the pouch increases in the direction of the circulation, and presses on the trunk of the artery beyond or coming out of the dilated part, so as intirely to obliterate its cavity.

From this cause, in every case of aneurism of long standing when situated in the extremities, the artery passing out from the tumour will be found on examination to be diminished in the capacity of its cavity. This diminution obliges a certain quantity of the blood appropriated to supply the parts beyond the disease, to pass to them by the anastomosing branches; a circumstance which becomes favourable to the success of the operation for aneurism should it be thought proper to attempt it. I have examined in the dead body several cases of aneurism which had affected the arteries of the lower extremity, and in all of them which had been of long standing and where many coagula had formed, the capacity of the artery passing out from the sac was much diminished. In four instances I found the cavity impervious, the patients having been cut off by some other disease, while in each of the four the aneurism appeared to be undergoing the process of absorption.

On examining the diseased parts in the dead body, the substance composing the sides of the aneurismal sac, is generally found to be as thick, and frequently thicker than the coats of the sound artery. This proves that the bag is formed not merely from a dilated artery, but also that much new substance is superadded. This new substance is not similar to the original coats of the artery, for it is neither muscular nor elastic, but seems to consist principally of condensed cellular membrane. I have frequently found the sides of an aneurismal bag three times as thick as the coats of the artery when sound.

As the tumour enlarges, it contracts adhesions to the neighbouring parts, and where the pressure is greatest produces absorption of the parts pressing on it. The preparations in this collection shew the effects of pressure on the vertebræ, ribs, and sternum.

In some aneurisms, the tumour enlarges to an immense size, and at last presses on the skin so as nearly to destroy its living powers by stretching it beyond its power of contraction ; sometimes the skin has given way and the patient has been instantaneously destroyed by the sudden gush of blood ; in other instances the skin has become discoloured, inflammation has arisen, and attempt at suppuration has taken place, and the patient has been destroyed either by the sudden gush of blood, or, what has often happened, by the gradual oozing of it. The aneurism may burst either on the external surface of the body, or into some of its internal cavities ; or it may destroy without bursting, by producing too great a pressure on parts essential to life.

Projecting tumours of different sizes, are often found to arise from the original and principal tumour ; these take place from causes similar to those which produced the first aneurism.

We often find many and occasionally very extensive ossifications of the coats of an aneurismal bag ; and sometimes a part of the bag shall be nearly cartilaginous. Nature as if aware of the chance of the sac giving way, appears by a deposition of bony matter to be inclined to give additional strength to the coats composing it, but by using brittle instead of elastic materials, accelerates rather than retards the event.

When after the patient's death we examine the contents of an aneurismal bag, we find that if the enlargement has been considerable, the cavity is more or less filled with coagulated blood disposed in concentric laminæ. The laminæ nearest to the inside of the sac and most removed from the circulating blood, are generally firm in their texture and have a dirty brown appearance. Those laminæ which have been more recently formed, and which are placed nearer to the circulating blood, are looser in their texture and redder in their colour.

I have met with tumours filled with concentric laminæ of coagulated blood, and which to all appearance had been aneurisms, situated on arteries and so attached to them as not to be separated without destroying their coats; but in them the whole of the cavity had been so filled with blood which had become solid, that no room was left for the fluid circulating blood to enter. Nature had thus by a process of her own effected the cure of this dangerous disease. Dr. Baillie has described the appearances found on dissecting two tumours, situated on the carotid arteries of a man, brought into the dissecting room in Windmill Street, in the spring of 1789. The whole of the arterial system of this man had a tendency to aneurism, but no defined swellings had formed in any other part; those in the carotid arteries had evidently been aneurismal, but were then solid, the cavities being completely filled with a coagulum adhering firmly to the inside of the vessels, and consisting of distinct layers as in common aneurism. (Vide Transactions of a Society for the Improvement of Medical and Surgical Knowledge, Vol. I.)

Instances have occurred where the whole of an aneurismal sac, containing much coagulum, has mortified and sloughed away, and the patient has eventually recovered. Nature here having had recourse to the same process that she uses in preventing hæmorrhage when parts of the body possessing large arteries mortify.

It has sometimes happened, that from the pressure of muscles in particular situations, the aneurismal sac has been propelled against the trunk of the entering artery so as to cause an obliteration of its cavity, and thus to lay the foundation of a natural cure of the disease by preventing the blood from reaching the tumour.

The pressure of an aneurismal tumour has been known to obliterate the cavity of an arterial trunk, situated in the vicinity of the disease, but which did not partake of the same disposition; thus the enlargement of the aorta, extending upwards, has pressed on, and obliterated the cavity of one of the carotid arteries. Mr. Astley Cooper has described an occurrence of this kind in the first volume of the Medico-Chirurgical Transactions.

In some cases of aneurism, all that can with safety be attempted is to forward those processes by which nature has in a very few instances, effected a cure.

Should any disposition to plethora occur in a patient labouring under this disease, it should be immediately removed, and the pulse lowered by repeated blood-letting. We should weaken, and keep under, as much as possible, the force of the circulation, and thereby diminish the dilating cause. When aneurism arises in the aorta, its progress may be sometimes retarded by forwarding those means which nature uses in the spontaneous cure, one of which is preventing the blood from circulating in the sac, by filling up its cavity with laminæ of coagulated blood. The sooner and the more frequently that blood can be made to coagulate in the sac, the greater chance will there be of a cure. In a former lecture I have stated, that during a fainting fit, the blood has an increased disposition to coagulate; from the knowledge of this, we might infer the propriety of bleeding frequently ad deliquium, to encourage the formation of more laminæ in the aneurismal sac; did not experience prove, that allowing the patient to faint by the sudden abstraction of blood, has been attended with much risk in some instances, and has produced death in others: the aneurismal sac forming a great impediment to the free circulation of blood when the patient is about to recover from the fainting; bleeding, therefore, should not be carried to the extent of producing actual fainting, but as near to it as possible.

The patient should be kept as much at rest as circumstances will allow. All laborious or long continued exercise should be avoided, so should every thing that has the least tendency to increase the force of the circulation. Low diet should be enjoined. Cough, costiveness, or any thing that will occasion straining, should as far as possible be prevented. Opium given with judgment, may diminish pain; and digitalis will on some occasions prove useful in lessening the action of the heart and arteries.

When the aneurismal swelling is seen externally, an equal and gentle pressure applied so as merely to afford support to the part, may for a time retard the progress of the disease; but any great or partial pressure will tend to produce a more rapid enlargement of the tumour.

The cure of aneurism consists in the removal of the tumour, or in the obliteration of its cavity. Various modes of treatment have been proposed and practised to effect this, even the amputation of the limb when the disease has been situated in an extremity; the late Mr. Pott recommended this mode of treatment, in preference to the operation for aneurism as practised in his time, and even this succeeded so seldom, that Mr. Bromfield, a cotemporary of Mr. Pott, objected to any operation.

In the old operation as it is now termed, the vessel was cut down upon, the sac opened and the blood scooped out; ligatures were then applied to the trunk of the artery immediately above and below the enlarged part, and the wound was dressed in the hope of its filling up and healing by granulations from the surface.

From the cases which I had collected, in which this operation was performed by different Surgeons, I thought myself justified in saying, that not more than one patient out of fifteen, on an average, recovered; but on conversing with Sir William Blizard on this subject, I find that in his practice, the success attending it has been much greater.

The general want of success in this operation arose from many causes, such as the difficulty which often occurred, from the deepness of the situation of the artery and the disease of the surrounding parts, of finding it so as to apply a ligature round it; from the probability of the artery so near the tumour being too much diseased to bear a ligature; from the danger attending a secondary hæmorrhage and the uncertainty of securing the bleeding vessel; and lastly, from the danger incurred in producing an open and generally a sloughing sore, so near to so complicated and important a joint as that of the knee.

To obviate these objections, J. Hunter proposed, in popliteal aneurism, to tye the femoral artery above the tendon of the triceps magnus muscle, and having thus removed the dilating cause, to leave the bag either to remain, or to be removed by the action of the absorbent vessels. He first performed this operation in the year 1785. The principles upon which such an operation was proposed, were so evident and just, and the success attending its performance has so much exceeded that of all those which preceded it, that in this country and on the continent it has superseded every other. Men of the greatest celebrity in our profession have applied the principle to every aneurism, where a ligature can be applied to the trunk of the artery between the tumour and the heart, and have performed the operation on every artery subject to aneurism, excepting the aorta, and the branches passing immediately from it to supply the viscera lodged in the great circumscribed cavities of the body.

So many useful remarks have been made on the nature of this dreadful disease, and on the operations to cure it, that it becomes unnecessary for me here to do more than to refer you to the observations published in the Transactions of a Society for the Improvement of Medical and Surgical Knowledge, by Sir Everard Home, who has given a very full account of John Hunter's operation, and to those of Messrs. Abernethy, Cooper, Lawrence, Travers and others, published in the different volumes of the Medical and Surgical Transactions.

Various methods have been tried by different Surgeons to compress the artery so as to obliterate its cavity. I do not feel that it is my duty here to comment on these different modes, or on the varieties of lesser importance, in the performance of the operation for aneurism affecting different vessels; did I even conceive it to be my duty to do so, it is rendered unnecessary by the treatise of Mr. Hodgson on the diseases of arteries and veins, a work which does the greatest credit to the industry and talents of the author. In that treatise, a very copious history is given of the nature of aneurism, and of the various modes of applying compression adopted by different Surgeons in aneurism of all the arteries which admit of the operation being performed, with a detailed account of the particular operations, and the average success of the whole, accompanied by the result of his own experience, and by very judicious remarks on that of others.

I shall only add, that when the tumour is small, the coats of the artery near it are often sound, and we should therefore, particularly in the carotid, subclavian, axillary, or iliac arteries, perform the operation, if the case will admit of one, as soon as the disease is ascertained to exist, and while the disposition has not affected other arteries; the operation at this period will be performed with more ease both to the patient and to the surgeon, and the ligature will be more secure.

I may be permitted to add, that I have in performing the operation for the popliteal aneurism, with the exception of one instance, used only a single ligature, and have always found it to answer perfectly. In the only case where I used a double ligature, the wound became unhealthy, sloughing took place, and the patient for a long time suffered from abscesses repeatedly forming in the thigh.

The anastomosis of arteries is so great, that we are justified in performing the operation on any artery which can have a ligature applied to it nearer to the heart than the aneurism, without opening into the cavities of the chest and abdomen.

Mr. Astley Cooper has tied the aorta in a dog, without producing very dangerous symptoms; the animal recovered, and he has preserved the artery, injected above and below the obliterated part, having killed the animal for the purpose of tracing the anastomosing vessels.

In examining the limbs of persons on whom the operation of popliteal aneurism has been performed, I have in one instance found the cavity of the femoral artery obliterated as high as the profunda, what remained of it forming a solid cord; in another, at the sac, and a little above and below where the ligature was applied, the artery had become solid. In others I have found the cavity of the artery filled with coagulated lymph from the ligature to the sac, and coagulated blood extending upwards, from the ligature to the nearest large branch of the femoral artery.

Note.—After this Lecture had been delivered, I was reminded by my son, Dr. J. A. Wilson, that Mr. Astley Cooper had tied the aorta in a man, under the justifiable circumstance of the patient being in immediate danger of bleeding to death from a rupture of the left iliac artery which had become aneurismal. The person survived the operation forty hours. On the body being inspected, there was no appearance of peritoneal inflammation excepting at the edges of the wound. A coagulum of blood of more than an inch in extent was formed in the aorta above the ligature, and coagula were also formed in the right and left iliac arteries.

LECTURE XV.

CONTINUATION OF ANEURISM, AND ON SOME OF THE DISEASES OF VEINS.

The spurious aneurism consists in a tumour formed by the escape of blood from the cavity of an artery into the surrounding parts, the orifice by which it escaped still continuing open. There are two kinds of spurious aneurism; the circumscribed and the diffused. In the circumscribed, the effused blood is contained in one or more cavities communicating with each other, and forming an evident and defined tumour.

In the diffused, the blood is contained in the cells of the cellular membrane.

Spurious aneurism arises from a division, (or as it has been techinally called) a solution of continuity in the coats of an artery.

Violent strains from falls, leaping, or other causes, have been said to produce it; but if the swelling does not take place immediately after the application of such violence, it cannot form a spurious aneurism; for if a strain only injures the coats of an artery, and the vessel enlarges afterwards in a particular part, it forms a true and not a spurious aneurism. A true aneurism may however by bursting form a false one. The ulceration of the coats of an artery may produce it. Pus in abscesses usually works its way to the skin without destroying the coats of arterial trunks; but I have known the femoral artery to burst, from having been long surrounded by the matter of a buboe, and I have also seen an appearance denoting that inflammation had taken place, and ulceration had been produced in the inner coat of an artery; had that action proceeded, this disease would have been the consequence; but the person died before the ulceration had gone through the coats. An artery punctured by a splinter of bone has formed this disease. The brachial artery has been punctured in bleeding, and the wound into it remaining open after the orifice in the skin was healed, has in several instances formed spurious aneurism.

The seat of spurious is much more general than that of true aneurism, and as it may take place from the division of any artery, may consequently be found in every part of the body.

When the tumour in spurious aneurism is perceptible to the sight, it produces symptoms and appearances similar to those of true aneurism, so that the two can only be distinguished from each other by the history of their origin; and both require a similar treatment.

When there is reason to suppose that an artery has been wounded or ruptured, although the skin closes, if a small tumour arises at the part possessing some pulsation, we may conclude that this disease has taken place. Such tumour is at first soft, and yields a little upon compression; it does not however do this so long as a true aneurism of the same size would, for the opening into the bag being less, the blood which enters it is more out of the circulation, and coagulates upon the whole sooner; the bag therefore seldom remains long stationary, but soon increases, and enlarges most where there is least support.

In healthy people it becomes circumscribed from the puncture being small, and the adhesive inflammation taking place immediately in the surrounding cellular membrane. These adhesions resist the progress of the disease at first, but as it proceeds they are unequal to do this, for at every pulsation of the heart the blood is forced in, and thus a gradual enlargement of the cyst must ensue It goes on to the same termination as true aneurism.

The treatment which it requires is the same as that of true aneurism, but may be more decided, as no disposition to form a similar disease is likely to exist in the other arteries.

In the beginning of this disease, when the blood can be pressed back into the cavity of the artery, we may try to retain it there by using moderate compression, taking care that all the neighbouring parts shall at the same time receive some support; by doing this we may retard the progress of the new formed cyst, but the instances are very rare of a cure being effected by these means. The compression is not recommended for the purpose of confining the sides of the artery together; but merely to assist the bag in resisting farther enlargement. But when we find that the disease is making progress, we should then cut down upon the artery, and apply a ligature above and another below the part. It has been recommended by some Surgeons not to perform this operation until the anastomosing branches have been enlarged by the additional stream of blood passing through them; it has also been recommended, to procure this enlargement more speedily, that partial pressure should be made on the artery; and instruments have been invented to produce this effect. I do not think that this delay is necessary, for the operation I am convinced will more certainly fail from being postponed until the surrounding parts are diseased, than from the want of sufficiently large lateral branches. No instrument can be used which can prevent the blood from circulating in an artery, without obstructing the circulation in some other part; and this in the neighbourhood of disease should always be carefully avoided.

In the diffused spurious aneurism, the blood passes from the injured artery into the cellular membrane; it forms the highest species of ecchymosis.

It arises after an artery is ruptured or punctured, when no adhesive inflammation takes place in the coats of the vessel or in the neighbouring cellular membrane, and the blood continuing to flow into the nearest cells is therefore forced on from these into others. The progress of this disease is generally rapid, and the distention of the surrounding parts considerable, the blood insinuating itself between all the solid parts, and coming in contact with the inner surface of the skin.

The tumour formed in diffused spurious aneurism, although not defined as it is in the other species of the disease, is easily distinguishable by the feel, for the skin pits upon pressure as it does in anasarca. Pulsation is not distinctly felt in it, although it is sometimes perceptible near the wound or opening into the artery. The pain which attends it is not very considerable at first, but it increases with the distention and at last becomes very severe. Stiffness takes place from the distention of the cellular membrane, and numbness and inability of motion from pressure on the nerves. The patient sometimes dies from irritation, sometimes from the quantity of blood that escapes from the vessels. I have seen an instance where so much blood was thrown out previous to death, as to produce a dark colour in the skin over the greatest part of the body. When the blood presses much upon the skin it sometimes causes gangrene to take place, and when the slough separates, should the artery not be secured, the patient may bleed to death.

When the wound in the artery remains open, and the vessel is in a part where it can be tied, there is only one mode of treatment to be pursued, which is that of cutting down upon and securing it by ligatures. All pressure should be avoided, for unless the artery is completely closed, the effusion of blood from its cavity will be greater upon compression being tried; and whether the artery is closed or not by compressure, the application of it will tend to increase the gangrenous disposition, which often threatens, and sometimes will take place notwithstanding all endeavours to prevent it. Should the artery be so situated that it cannot be tied, we must then have recourse to the means known to be useful in the stoppage of internal hæmorrhage.

When the hæmorrhage is stopped, our next consideration is how to dispose of the effused blood. If incisions are made for this purpose, they should be confined to one or two, and made only where the blood is felt to be fluid, for there only can they prove useful; they often tend to increase the disposition to gangrene, which parts in this state are always much disposed to assume. The blood also being healthy when first effused will have partially coagulated in the cells of the cellular membrane, from which it will be impossible to remove it by incisions; it must then be left to be absorbed, and in most cases, this is the best practice from the first. If inflammation should take place in the tumour, it should be allowed to proceed to suppuration, and the abscess should not be opened until it points. In most instances it should be allowed to burst of itself; poultices should be applied to forward this.

When the bleeding has stopped, and the skin has been distended by the effused blood to bursting, without suppuration having taken place, poultices should be applied, and the coagulated blood should be allowed to be thrust out by the natural contraction of the parts. When the skin is much bruised, and the quantity of effused blood considerable, the safest applications to the part at first are poultices; for gangrene and an extensive sore may be produced by very stimulating applications, or by incisions and attempts made to scoop out the blood in this state of the skin.

It occasionally happens, that a large quantity of blood escapes from the rupture of some vessel, without any wound in the skin taking place, which does not coagulate but remains fluid; when thus thrown out in the neighbourhood of a large artery, it has something of the feel, and may be mistaken for a spurious aneurism; but if after a certain period the tumour does not increase, although an indistinct pulsation continues, we may be certain that it is not aneurism. The ecchymosis which frequently takes place in a child's head at birth has often a feel of pulsation, from the sutures and fontanelles not being closed; this kind of ecchymosis requires nothing to be done, as the blood in general is soon absorbed.

Ecchymosis taking place in consequence of a blow on the scalp, sometimes produces an appearance and feel a little resembling a depressed portion of bone; this may usually be distinguished from a depression by its having a more regular edge, and being on the whole more extensive. The edge, in all probability, is formed in this case by the adhesive inflammation uniting the surrounding cells of the cellular membrane together, to confine the effused blood. When we know that the blood is certainly fluid, and confined under a thick fascia, we may venture to puncture the fascia, and when the blood has been evacuated, should endeavour by moderate pressure to heal the wound by the first intention; but should it suppurate, it is to be treated as any other abscess of the part. In cases where an opening is not made, and where the effusion of blood is not attended with inflammation, pressure properly applied is perhaps one of the most certain means of stimulating the absorbents to remove the blood.

The species of aneurism termed varicose, was first discovered and explained by Dr. William Hunter. It takes place in consequence of a puncture having been made through the coats of a vein into the cavity of an artery lying underneath and in immediate contact with it, the wound in the skin and the upper part of the vein having healed; but the wound in the under part of the vein and upper part of the artery continuing open, the contiguous orifices of the two vessels become connected together by adhesions taking place in the cells of the cellular membrane, and thus a channel is formed for the blood to pass from the artery directly into the vein.

It has occurred more frequently from a blunt lancet having been used in bleeding, or from the unskilful mode of performing that operation measuring by the thumb and finger the depth to which the lancet is to enter, than from any other cause. It appears at first as a pulsating tumour, the vein being evidently dilated and forming it. When the vein is compressed on the side next to the heart, the tumour increases, as it also does when the arm hangs down, and in this situation, it is sometimes attended with slight pain, but both the tumour and pain decrease when the arm is held up. If the vein is compressed on each side of the tumour, the blood may be pressed back into the artery, and the tumour will subside. If the artery is compressed near to the heart, the tumour will subside from the blood not entering it, and when the compression on the artery is removed, the blood can be felt and heard to re-enter the tumour by a particular thrill, and with a buzzing noise.

The blood in this disease always remains fluid, and this most probably is owing to its being kept in continual motion. In its progress the disease is not found like other aneurisms to increase so as to endanger the life of the possessor; it soon attains a certain size, and either remains stationary afterwards, or increases by very slow degrees. Since Dr. Hunter made its nature first known many cases of it have been published. It has been ascertained to exist for forty years and more, without any considerable increase or without having produced much inconvenience. I watched its progress in a patient from the year 1784, to 1813; the tumour was then about the size of the half of an orange, and since that time I have not seen the person, who may be still alive. I have heard of no instance of its having terminated fatally.

In the treatment of varicose aneurism, considerable advantage is certainly derived from the discovery of its real nature. Formerly the disease was blended with spurious aneurism, and subjected to the same treatment with that affection; now, years of anxiety, and a painful and sometimes even a dangerous operation are saved to the patient. No operation should be performed; the tumour may be moderately supported, and this is all we should attempt. All violent exertions of the limb should, of course, be avoided.

In those affections which have been termed aneurisms from anastomosis, and in the nævi materni, I have never been able to discover whether the cavities which appear like cells filled with blood were formed by dilated arteries or enlarged veins. From the throbbing or pulsation in them I should conclude that they were in arteries, but the colour of the blood in them is of the venous character. I have known these affections enlarge most rapidly, but I have also known them to remain stationary for years. Many cases have been published, in some of which compression equally applied has cured the disease, and in others exasperated it; cases have occurred where no regular pressure could be used, and where a constant application of cold has been useful in preventing the progress of the disease; in other instances, the trunk from which the arterial branches of the tumour arose has been tied with doubtful success; where the part cannot be removed, we are bound to try such means, but where the knife can extirpate the whole of the diseased part, the use of it should not be delayed.

I once had an opportunity of inspecting the dead body of a young person in whom during life, a very small degree of pressure on any part of the body used to produce the appearance called black and blue to that degree, that the nurse in dressing him, although a very careful woman, frequently left the impression of her fingers on different parts of his body; I have frequently seen the child with bruises of a livid colour on most parts of the body, arising from falls or even pressing against any thing with the slightest force; if a pin happened to scratch him, a great difficulty occurred in stopping the bleeding, and the application of a single leech was productive of so much danger from the continuance of the hæmorrhage, that the child's life was nearly lost. The complexion of the child was fair, when not bruised, and the appearance delicate, but not unhealthy; the pulse was full, but never hard, and the functions of the viscera generally seemed to go on as in other children; when between three or four years of age, the child bit its tongue; there was an impression of teeth both on the upper and under surface but not very deep; the bleeding from both wounds having continued for some hours, and having resisted all attempts to stop it, I was desired to see the child. I tried compression in various ways, and every kind of styptic, which produced a temporary, but no permanent effect; so that although the child lived five days, and during that period I saw it several times in the day, and frequently remained an hour or two with it, though I never failed in producing a temporary stoppage of the bleeding, it was renewed almost as soon as I left the house. I included the whole of the bleeding surface in a ligature, which for a short time stopped the hæmorrhage, but ulceration very soon took place and a fresh bleeding occurred; to use the needle was impossible, as the least puncture produced a bleeding almost as violent as that from the wound. I destroyed the surface by the application of caustic, but the eschar was soon thrown off and the bleeding renewed; the child became very weak, and as the bleeding occasionally occurred during sleep, was watched over very carefully; but on one occasion, when upon the supposition that he was asleep, he had not been looked at by the nurse for half an hour, she found that a very slight bleeding not exceeding a tea-spoonful had taken place, and that the child was dead.

Those substances which disposed the blood to coagulate, seemed to have more effect in restraining the bleeding for a time than those which usually dispose the artery to contract. The father of the child was a gentleman of a large and very strong make; the mother a lady possessing very good health, and they had several children of both sexes. It was remarked, that all the male children were nearly similar to the one who died in the liability to have blood extravasated on the least pressure, and that none of the females were more subject to this effect than other children. I was requested to enquire by inspecting the body into the cause. The whole of the viscera appeared to be perfectly healthy, but the aorta and every branch sent off from it seemed to resemble veins more than arteries; the coats were not more than one half of their usual thickness, they had not sufficient elasticity to preserve their cylindrical form in the dead body when deprived of blood; and even in the popliteal artery, notwithstanding there had been so much loss of blood, the artery did not appear to be contracted, nor were any muscular fibres to be discovered in its coats. It appeared to me that from a deficiency of the muscular coat, these small arteries, when partially pressed, gave way and allowed the blood to escape into the cellular membrane, although the coats were too strong to be ruptured by the force the heart used in propelling on the blood. Another circumstance which seemed an additional proof that want of muscularity in the artery was the cause of the bleeding not stopping was, that none of the numerous bruises were ever attended with symptoms of local inflammation, but the blood extravasated was soon removed by the absorbents, so that no abscess or even boil had taken place at any time on the child's body, excepting the vaccine pustule, and even that was attended with less inflammation than usual The veins appeared to be as strong and as healthy as in any other child. This being a case which I had never met with or heard described, I have mentioned it here; and should I be called in to a similar one, the practice I should adopt, if pressure did not succeed, would be the forwarding of those means which tend to dispose the blood to coagulate, as the arteries seemed to have no power of contraction so as to stop the bleeding from that property, which proves so useful in other cases. The arteries of the other boys seem to have increased in size as the children grew up.

ON THE INFLAMMATION OF VEINS.

When on the subject of inflammation generally, I have already alluded to this action as taking place in veins, and have described and shewn the appearance of the coagulable lymph adhering to their internal surfaces. Veins not only inflame when an opening has been made into their cavities; but they also assume this action from passing through or coming from an inflamed part. Veins passing from an extensively inflamed part, have also been found to contain pus, and to have had the adhesive inflammation taking place in parts of the vessels to contain and confine it. Veins thus have had abscesses in their cavities, a chain of which I have seen passing to some considerable distance from the part where the inflammation first began.

John Hunter has observed, that the inflammation of the internal surface of veins is so common, that he had seldom seen an instance of suppuration in any part furnished with large veins, where the appearances of inflammation of their cavities had not been evident after death; and where the inflammation of the part was the most violent, that there the veins were most inflamed, and there also the purest pus was found when the veins suppurated. For when the vessels were traced from this part either to or from the heart, the pus according to the degree of distance from the inflamed part, had more or less of fluid and coagulated blood mixed with it.

In the third volume of the Transactions of a Society for the Improvement of Medical and Surgical Knowledge, I have described the appearance of, and the effects on other parts, produced by an obliteration of the vena cava inferior from inflammation, and have there stated that I had seen the above-mentioned observations of John Hunter confirmed in most parts of the body, as to the appearance of inflammation on the inner surfaces of veins coming from inflamed parts, but more frequently and more remarkably in those coming from an inflamed uterus; and that in the case alluded to, and in others of nearly a similar nature which I had met with, I could trace the inflammation and consequent obliteration of the vena cava inferior to inflammation having first extensively affected that important organ. I had often long before this found pus in the cavities of the veins leading from the womb; for on inspecting with the late Dr. Clarke the bodies of many women, who during some months, were successively attacked with puerperal fever, of which they died in a few days after delivery, in the Store-street Hospital; we found in all of them that the peritoneal coat and substance of the uterus had been inflamed, and that in most of them pus had been formed, and often in a large quantity in the veins of and leading from that organ.

I have already explained that the action of inflammation is in the vasa vasorum, and that the coagulable lymph thrown out from these vessels must immediately become solid and adhere firmly to the inside of the vein; otherwise from mixing with the circulating blood it would be carried on to the heart.

Our acquaintance with the circumstances attending the inflammation of a vein, will enable us to account for the inflamed arm which occasionally takes place after the operation of bleeding, and which has so generally been attributed to a nerve or tendon having being injured; although a similar kind of inflammation has taken place after the opening of a vein in a part of the body where no tendons could have been injured, and where no branches but those of the smallest nerves could have come in the way of the lancet. These inflamed arms happen as frequently in persons whose constitutions are healthy as in those disposed to disease; and they happen much more frequently after the operation of bleeding, than in wounds which are more extensive, and which are made in parts where nerves and tendons would be more liable to be injured, although indeed in almost every wound a nerve of large or small size is likely to be left in a half divided state.

The wound made in bleeding not healing by the first intention is the most probable cause of the inflammation of the arm. In cases where the wound in the vein unites, but where that in the skin and cellular membrane remains open, either from irritation in consequence of the wound not healing, or from some morbid matter from the wound having entered the absorbents, these vessels sometimes inflame. The red lines which usually point out the course of these vessels when inflamed and their superficial situation, allow of these cases being easily distinguished from inflammation of the veins, the trunks of which do not appear to be affected. I have known several abscesses to form in succession in the absorbents, and the glands in the axilla to inflame and suppurate from this cause.

It sometimes happens that union does not take place in the coats of the vein, and in consequence of this its cavity inflames in both directions to a considerable extent, from and towards the heart, and the neighbouring parts partake of the inflammation. The inflammation and suppuration are, in some instances, confined to one spot by adhesions, in others, a series of abscesses take place between the vein and the heart. Should adhesions not take place, the pus formed on the inflamed surface, mixing with the blood, is carried on to the heart, and by being so, in some instances, has, in all probability, been the cause of death; but death has also been produced by the inflammation spreading along the vein to the heart. Inflammation of the jugular veins in horses has after bleeding been often known to produce death, and in those cases where the horses have recovered of the inflammation, the veins have always remained impervious.

In every case where the action of inflammation in a vein runs high, the whole of the patients system is much affected, for, in addition to the constitutional affection, which the same degree of inflammation in any other part would produce, the pus when formed must pass immediately into the circulation, and thus adding to the disorder may even render it fatal.

The consequences which may thus arise from an operation apparently so trifling as bleeding, both to the character of the Surgeon and life of the patient, should induce him to be very attentive to the cleanness and sharpness of the lancets he employs, to the mode of closing the wound, and also to that of binding up the arm. A compress of linen should be used, and not sticking plaister, and this should be applied only sufficiently tight to keep the inside of the vein in contact until union takes place. In cases where inflammation arises, the same treatment must be had recourse to as that which subdues it when arising from other causes; but should an abscess actually form, a compress should be applied and kept on the vein above the affected part, between it and the heart, so as to retain its inner surface in contact and by giving a chance for adhesion to take place, thus to prevent the disease from extending to the heart.

ON VARICOSE VEINS.

The veins in different parts of the body, but more particularly those belonging to the lower extremities occasionally enlarge irregularly, and form unequal knotty protuberances. The term varix is applied to a tumour of this nature.

The veins of the legs when they assume this disease are enlarged at particular parts, and the protuberances formed seem to be much regulated by the valves of these vessels, valves being always found where any of these swellings take place. The vein leading towards these enlarged portions then increases in size, and begins to run in a waving or what is called a zig-zag direction; and as the disease goes on the regular appearance of the vein is lost, so that instead of a vessel, a number of these unequal knobs appear, which are of a blue colour from the dark blood shining through the coats of the vein.

When the limb is in a depending position these knobs are very turgid with blood; when the limb is recumbent they become less, and in some instances disappear. They are void of pulsation, and are not at first attended with any other pain than that which arises from distention and weight; this pain is never acute, but is dull and heavy. The swellings in general are at first perceived below and about the ankles, and gradually extend up the leg and thigh. The distended veins sometimes can be traced into one large trunk; but sometimes the whole of the venous trunks are enlarged, their coats at the same time being thickened and diseased. The preparations now produced shew the increase of thickness in the coats, and even the partial obliteration of the cavities of these vessels.

Whatever obliges the blood to accumulate in the veins, by obstructing its return to the heart, may occasion this disease. It often proceeds from tight gartering; washerwomen who stand at their work in a hot room and in a position somewhat inclined, are very subject to be affected by varicose veins of the legs; and so are women during their pregnancy, from the uterus pressing on the trunks of the veins in the abdomen. Plethoric men, and those in whom there exists some obstruction to the blood circulating freely through the liver, are subject to them. Men working in much heat are very apt to be affected by them, particularly glass-blowers; in these last, the superficial veins are usually in a state of comparative distention from the heat of the atmosphere in which they usually live, as well as from the circulation being occasionally retarded, and the blood is of course accumulated in the superficial veins during the act of blowing the metal.

In proportion as the veins are more dilated, the circulation of blood through them becomes more difficult, and this occasions their further enlargement. In the progress of this disease, the affection often becomes extremely painful, and the varices sometimes burst occasioning profuse hæmorrhages, and laying the foundation for foul and most obstinate ulcers.

The treatment of this disease, as practised by the older surgeons, was very severe; for they sometimes used the actual cautery, so as to destroy the veins by the burning iron, and sometimes removed them by the knife, and then applied heat to stop the bleeding.

In the beginning of this affection, we should prevent any partial pressure on the veins that might obstruct the free return of blood to the heart, and at the same time, should give proper and equal support to the vessels by the employment of rollers, or laced stockings, taking most particular care in the application of these bandages, that they produce no more pressure on one part of the limb than on the rest. Cold water, vinegar and water, and gentle astringents, may be employed to wet the bandages, and friction with the hand or flesh brush will often aid the free return of blood. Costiveness should of course be prevented, and in plethoric people, blood should occasionally be taken from the arm.

When the veins are much enlarged, and the different branches in the leg can be traced into one or two trunks, an incision being made through the skin on this trunk or trunks, and a ligature then carried round them effectually stopping the circulation, the blood then coagulates in the vessels, and thus preventing more from entering, cures the disease by obliterating the cavity of the vessel.

When this operation is performed, the patient should be in a standing posture, as in that position the veins will be better seen from being turgid with blood. This operation, however slight in appearance, is not unattended with danger, for cases have occurred where the patient has been destroyed by inflammation spreading from the tied vein to the heart. It has sometimes been found necessary to extirpate the whole plexus of enlarged veins, to prevent almost continual hæmorrhages, or the formation of ulcers of a very painful and dangerous nature. In some instances it has been necessary, when the veins have burst, to apply a ligature to stop the bleeding; but gentle and equal pressure, with the use of the milder styptics, will often succeed.

The veins of the scrotum sometimes enlarge and become varicose. The pain attending this enlargement, is not great until the disease has made considerable progress, it then becomes dull and heavy; part of the dress being worn tight may produce this, as the waistband of the breeches; but it not unfrequently arises from the pressure of the pad of a truss:—it may be remedied by removing the cause of obstruction to the free return of the blood, and suspending the scrotum without pressing on the trunks of the veins. Cold and astringent applications to the skin of the scrotum are also useful.

The veins of the spermatic chord not unfrequently become varicose; when so, there is a peculiar knotty unequal feel immediately above the body of the testicle, attended with a heavy, dull pain when the person is in an erect posture, both of which subside considerably when that posture is changed for the horizontal one and the scrotum is at the same time supported. The enlargement of the veins sometimes extends up the spermatic chord through the ring, and from this circumstance, the disease is not unfrequently mistaken for an omental hernia. A little attention will, however, enable any person readily to distinguish between the two diseases; both will subside on the person lying down; both will return when the person is in the erect posture if no pressure is made on the ring; if such pressure is made, in omental hernia there will be no swelling; but if the veins are varicose, the tumour, notwithstanding the pressure, will immediately return. Cirsocele, as this disease is called, may arise from the testicle being weakened from being made to sécrete too frequently and too much; from a tight dress; from the improper application of the pad of a truss; even standing for a length of time, or stooping much, will in weak constitutions produce it; and it often attends habitual costiveness. To remove it, every thing about the upper part of the pelvis should be loose, but the scrotum and testicle should be supported by a bag truss so contrived as not to press on the chord. Astringent applications to the scrotum should be frequently used; costiveness should be prevented, and the secretion of semen not unnaturally forced. In very considerable enlargements, sometimes the veins have been tied, and in other instances, a plexus of them has been removed; but these operations must always be attended with some risk, and are very seldom necessary. It is an affection often made use of by unprincipled pretenders to surgery to pick the pocket of the patient and greatly to alarm his mind, so as in some instances to derange his powers of reasoning: although cold water applied externally will often cure it. I know of two instances of suicide taking place, from the mind of the patient being misled and alarmed as to the consequences of this almost imaginary disease.

When the veins immediately within, or situated on the verge of the anus, become varicose, they then form the troublesome disease called hæmorrhoids, or piles. Piles are tumours in the above-mentioned situation containing blood, and at their first formation consist of dilated veins. It has been supposed by some surgeons, that the arteries of these parts were also dilated; but when carefully examined, either in dead bodies or in living patients, piles will on their first formation invariably be found to consist of dilated veins. They form tumours of various sizes, from that of a small pea to a pigeon's egg, and are often larger. They are sometimes of a regular bulbous form, sometimes oblong, and often irregular. When near the anus, they are covered with the cuticle, and when higher up, by the internal membrane of the gut.

As the disease increases, the smaller branches entering the dilated vein enlarge, inflammation comes on, and the cellular membrane connecting them partakes of this action, and becomes thicker; coagulable lymph or blood is now thrown into the cells, rendering the pile harder, more complicated, and more painful to the touch; in this state, the tumour has been called a blind pile. It often bursts and discharges blood through one, but more frequently through several small openings; the disease is then called the open, or the bleeding pile.

Tumours of this kind are not very painful at first when situated on the outside of the sphincter muscle; but when they are so situated as to be pressed on by it, they become exceedingly painful.

These tumours at their first formation are soft and yielding to the touch; the blood contained in them appears to be entirely fluid, and is easily pressed back into some other part of the vein; but in time, from the connecting cellular membrane having inflamed and thickened, they acquire a firmer consistence, and a more fleshy feel.

After the tumour has burst and discharged blood, it will sometimes gradually subside; but it will occasionally after this increase in size, assume a more livid colour, become more painful, and discharge blood on the slightest touch, so as greatly to harass and weaken the patient.

The chief causes of hæmorrhoids are those which prevent a free return of blood in the inferior mesenteric vein, such as costiveness, pregnancy and pressure from situation of body; thus they often take place in people of a sedentary life, more particularly if such persons are seated when at their daily work, as in weavers, coachmen, and tailors. They occur more frequently in women than in men, also more frequently in advanced life than in youth. The use of any drastic purge irritating the rectum will, if long persevered in, produce them; so will the habit of sitting long when at stool.

Many of the older practitioners, conceiving that the discharge from them was salutary, were averse to any attempts being made to stop it, they considered it as an attempt of nature to get rid of the redundant and noxious parts of the blood, which by remaining, they thought, would be the cause of melancholy, gout, asthma or madness.

As we now know the causes producing them, we may certainly endeavour with safety to cure them, excepting in very old people where they have continued long and without injury to their general health, for here making any change is often attended with danger.

The cause must first be removed. Sedentary habits must be corrected by exercise, and costiveness by some mild aperient medicine. In pregnancy as the cause can only be removed by delivery, we must alleviate the symptoms as they occur.

When the inflammation is not violent, sedative and astringent lotions and ointments may be applied, with compressure; but when violent, leeches, scarifications, emollient decoctions with opium may be necessary. They often require removal, sometimes by the knife, but more frequently by the application of ligatures. Caustic must be used with caution in this part, and in every other where there is much cellular membrane. To say more on the treatment would only waste the time of this audience, as the lectures here were not intended to be elementary, although from unavoidable circumstances they must have often bordered on that quality.

In the Museum Lectures on Surgery which I have now concluded, it has been my wish throughout to offer to your attention such pathological and surgical remarks as would be best illustrated by the healthy structure and functions described in the anatomical and physiological division of the course. It appeared to me that there was a natural and established connection between the anatomical and museum lectures, which it would ill become me to disturb, even should it suit my convenience to do so. My task however, as was to be expected, has been rendered more easy to myself, and I hope not less useful or instructive to my audience, by an adherence to the great and rational principle which seems to have been contemplated in the original distribution of the fifteen discourses which I have had the honour to deliver to you, I mean the principle of explaining the action of disease by previous observations of the structure which it affects.

Speculative disquisition seems to be forbidden by the existing arrangement of the lectures, and therefore little has been introduced in the present course. We were at first engaged with anatomy and physiology, and during our more recent enquiries we have been constantly referring to the preparations of the museum.

Of the particular subjects that have been selected for the lectures, but little need be said. The blood and its containing vessels, to the exposition of which system the illustrious founder of our museum is chiefly indebted for the immortality he enjoys, seemed to me, on many accounts, to promise the most useful and interesting matter for the early part of the course; and if this preference of the vascular system was authorised by its importance, there can be no doubt of the propriety of having selected the action of inflammation and its consequences, with hæmorrhage and the diseases connected with the vascular system for the theme of the concluding lectures.

Whether or not these subjects have been treated in a way that their importance merited, it is for you, Gentlemen, who have honoured these lectures with your presence, to decide. You will recollect that some difficulty must necessarily attend the arrangement of lectures fitted to such an audience. I have throughout the course consulted to the best of my power your opinions collectively, and have studiously endeavoured to meet the wishes of both the younger and the more matured part of my hearers.

I now beg to offer my grateful thanks to you Master, to the Court, and to the Members of the College, also to those Gentlemen who though still Students will soon be Members, and to the Visitors, for your attendance, and to assure you that the difficulty of my undertaking has been most agreeably lessened by the kind and patient attention with which you have listened to me during the performance of it. With similar feelings Gentlemen, to those of my late learned and most ingenious colleague, whose recent resignation of the Lectures on Comparative Anatomy which he was so well suited to deliver, we all must regret, I thank you very sincerely, and wish you every success and happiness in the honourable practice of your profession.

FINIS.

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