dirt is scraped out. That which these people call the dirt is the exquisite and complicated structure of the intestinal mucous membrane. But, while the mucous membrane is scraped out from within, there is also scraped off from without the circular coat of muscular fibres. The result comes to be that the intestine is converted into a comparatively unsubstantial material, consisting of two parts, or bands, one more slender than the other. When the mesentery is stripped off by the butcher, the peritoneal covering of the gut shrinks into a narrow strip, and this, with some longitudinal fibres, constitutes the more slender of the two parts to which the intestine is reduced by this process of scraping. The other part is the essential material from which the catgut is prepared, and this is neither more nor less than the submucous cellular coat of the intestine. When I first visited a catgut manufactory, I was astonished to find that, after this scraping process, the intestine could be blown up still as a continuous tube, as you see can be done with this specimen, which has been treated in the manner I have described. This exquisitely delicate structure is a beautiful anatomical preparation of the submucous cellular tissue, though made in so rude a fashion. This coat of the intestine, which in the sheep has this extraordinary toughness, is the material out of which the catgut is prepared. For what the manufacturer terms the "ones"—the thicker form of ordinary catgut—all that is done is to twist the entire tube by means of a wheel, like a rope in a rope-walk, up to a considerable degree of tightness, and then allow it to dry. It is afterwards exposed to the fumes of burning sulphur, and for some more special purposes it is bleached by the action of potash. But the essential thing is the twisting and drying. It can be prepared without the use of sulphur as well as without the use of potash. Some specimens which I have here are prepared by water only, without the use of any other ingredient. This exceedingly beautiful structure, as I think we must consider it, as fine as a horse-hair, is prepared without any reagent whatever, nothing but the animal tissue twisted and dried. For the finer kinds the tube of the submucous coat is split up by means of razor-blades, more or less numerous, according to the degree of splitting required, connected with a conical piece of wood, which is pushed along the tube.

Such, then, is the material with which we have to deal. The first of the more recent experiments which I performed with reference to it was made with the view of ascertaining, if possible, what part the water played in the ingredients used for the preparation by our old method. If I steep unprepared catgut in a mixture of dry carbolic acid and oil, however long it be so steeped, although it will be of course abundantly aseptic, it remains utterly unfit for the purposes of the surgeon; a knot upon it would still slip in a wound. But if, instead of using carbolic acid in the crystalline state, we use carbolic acid which has been liquified by the addition of a little water, we get in course of time a properly prepared catgut. I wished to ascertain how much water was required. The carbolic acid would enable oil to dissolve a certain amount of water; would that amount of water be sufficient which carbolic acid enables oil to dissolve? Accordingly, I prepared jars of carbolic oil, some containing the full amount of water we had used hitherto, some a smaller quantity, and some none at all, and placed in them portions of the same hank of catgut. In due time, I proceeded to examine the result by taking portions of gut and putting them into warm water and leaving them for a certain time, in order to ascertain how the knots would hold. To my great surprise, I found that which had been steeping in the carbolic acid and oil without any water was just as good as that which was in the carbolic acid and oil with the water. This was contrary to distinct previous experience. Reflecting on the matter, I saw that the only possible explanation was that the catgut was already, so to speak, prepared before I put it in the liquid. Now it so happened that the catgut I had used was several years old; and it turned out that mere age of the catgut prepares it; that in proportion to its age it is rendered less liable to be softened by water or by blood-serum, and a knot tied upon it will hold better. And thus I had for the first time, I believe, scientific evidence of the truth of what is popularly spoken of as the "seasoning" of various articles made of animal products. I asked a person who sold violin-strings if there was any result from keeping the strings a long time. He said, No; the only result he knew was, that they would probably get rotten. But it so happened just about that time there came an old fiddler to amuse the patients at the Royal Infirmary, of Edinburgh, at Christmas-time. The weather was wet, and he said that his fiddle would not work properly because the fiddle-strings were not properly seasoned. So that he was aware that fiddle-strings, which of course are catgut, are liable to seasoning and require it. This was a very important fact, because it served to explain the success that I had had on my earlier experience with the catgut before I knew at all the proper mode of preparing it. I look back with horror at some of my early procedures with catgut. I have operated, for example, on an irreducible ventral hernia, opened the sac, divided the adhesions, returned the protruding intestines, stitched up the mouth of the sac with the catgut, and then applied stitches at considerable intervals in the skin. All went perfectly well, but the mode of preparation that I then used, if I had worked with catgut recently made, must have ended in utter disaster, the knots must have slipped in a few hours, and the intestines must have been protruded through the wound.

[*To be continued.*]

CLINICAL LECTURES
ON
SOME POINTS CONNECTED WITH THE TREATMENT OF WOUNDS.

By WILLIAM MACEWEN, M.D.,
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LECTURE II.—THE DRAINAGE OF WOUNDS (BUTTON-SUTURES).

GENTLEMEN,—In continuation of our subject, we now come to the drainage of wounds. When the arteries have all been secured, there will still be a slight oozing of blood from the tissues, which it is impossible at times to prevent, especially when large surfaces are involved. Besides this, an exudation of serum must be expected, in greater or less abundance, according to the irritation. If the edges were accurately brought together, so as to close the wound completely, the blood and serum would collect in the interior of the wound, and prevent, for the time being, the coalescence of the cut surfaces. The irritation produced by this tension would be apt to induce suppuration. In order to avoid this, provision must be made for the drainage of the wound. This must be suited to the material to be drained—blood, serum, and, possibly, pus. As far as the first two are concerned, the physical character on which their drainage depends are sufficiently alike to permit of their being considered together; while pus, though it varies much in density, must be looked on separately.

India-rubber Tubes: their Disadvantages.—The introduction of systematic drainage of wounds was due principally to Chassaignac, who effected his purpose by the use of India-rubber tubes, which still bear his name. These tubes, familiar to all of you, did excellent service, greatly facilitating the healing of wounds. There are, however, certain disadvantages connected with their use in antiseptic surgery, when the material to be drained is reduced to the minimum. They cause irritation by acting as foreign bodies, interfering with the rapid healing of the parts in their immediate vicinity; they blacken the protective plaster, showing the probability of the presence of irritating compounds; and they necessitate the dressing of the wound, in order to shorten or otherwise adjust them. These are objections which may scarcely be appreciated by those who do not practise antiseptic surgery; but, the nearer we approach perfection in the treatment of wounds, such sources of irritation will become the more prominent, and the greater will be the desire to obviate them.

Carbolised Catgut: its Disadvantages as a Drain.—Probably animated by such a desire, Mr. Chiene proposed the use of carbolised catgut as a substitute. Eight or twelve threads of carbolised catgut would effect the drainage of the wound through capillarity, and its absorbability would prevent the necessity of dressing the wound. Theoretically, this had considerable advantages; but, practically, it had objections. It was found that carbolised catgut, soon after introduction into the wound, swelled and softened. It became closely connected with the neighbouring tissues, by virtue of its infiltrations with new cell-growth, connected with its absorption and organisation. When it was found necessary to remove it, it sometimes set up inconvenient bleeding, from the rupture of newly formed minute vessels. Its absorbability was its main advantage; but the rapidity with which this was accomplished destroyed, in great measure, its utility—as it was difficult to presage whether, in a given wound, drainage might not be required for a longer period than a few days, beyond which the carbolised catgut was useless. Its physical character precluded it from draining pus.

Horse-hair as a Drain.—Mr. White of Nottingham proposed, as a substitute, horse-hair, on account of its cheapness, its increased capillarity, its non-absorbability, and its non-irritating properties. As you see horse-hair very frequently used as a drain, I would like to draw attention to several points which help to make the drain efficient. In purchasing horse hair, it has not been pointed out that most tails used commercially are dyed. It is all the more important to keep this in mind, as black horse-hair has been recommended. Now, most tails contain naturally a few hairs of a different colour from the prevailing one. They

are therefore dyed, so as to obtain the whole hairs of an uniform black colour. This pigment is to a certain extent discharged by soaking in water, and more so by steeping it in carbolised solution. Some have been seen which discharged colour after the tenth washing. It has, therefore, been found better to secure a tail in a natural condition. Then thoroughly wash and boil it, to rid the hairs of any foreign matter which may be adherent to them. Next steep them in a watery carbolised solution, and dip them into a similar solution prior to insertion into the wound. The thick end of the hair ought to be inserted into the wound, in order to have the flow of the fluid in the direction in which the scales overlap.

How Capillary Drains act, and what they are suitable for draining.—The next point is to inquire how horse-hair acts as a drain, and what it is suitable for draining? A wisp of horse-hair introduced into a wound is supposed to act by capillarity. It can do so in two ways: first, by the minute spaces existing between the individual hairs forming capillary tubes; and, secondly, by the flow of the fluid along the outside of the hair. In this connection, there are one or two points regarding capillarity which it is necessary to remember. First, the finer the tube the higher will the fluid rise in it; consequently, in this respect, hair will be a better capillary drain than most sizes of catgut. Second, when a capillary tube of unequal diameter, wide at one extremity and narrow at the other, is placed horizontally, fluids forming a biconcave miniscus flow from the wide toward the narrow end. The hairs ought, therefore, to be spread out in the interior of the wound, and brought together near its lips, when tubes or spaces will be formed between the hairs, having their wide ends toward the inside of the wound, and their narrow extremities at the debouchement of the drain. Third, all liquids do not rise to the same level in capillary tubes, while some are actually depressed within them. Serum and liquid blood rise within these tubes, while laudable pus does not do so to any marked extent. For blood and serum, horse-hair is an excellent drain, but for pus it is not reliable. Even for blood and serum, the entire dependence on capillarity is a questionable practice, as this force is at best a feeble one. When hair is placed in a hollow in the wound, and is cut off close to the lips of the wound, these being at a higher level than the interior, the fluid will require to mount up; it then acts feebly as a drain, even for serum and liquid blood. Of course, it may be said that drainage can be effected by making an aperture in the most dependent part of the wound, and calling in the aid of gravity—a very excellent plan, but one not always commendable for other reasons.

Capillary Syphon drains.—There is, however, a much more efficient way of using the hair as a drain: by converting the tubes found between the individual hairs into syphons. The power of the syphon is much greater than that of capillarity. The wisp of hair may be easily formed into a syphon by leaving the portion on the outside of the wound longer than that which remains in the interior. Before a syphon acts, a vacuum requires to be made, or a liquid communication established between the fluid to be drained and the long arm. This communication can easily be effected by dipping the hair into a weak carbolised solution before introducing it. The capillary action possessed by these hair-spaces also aids in establishing the flow. [Experiments, showing the superiority of the hair-drain as a syphon over its purely capillary action, were exhibited.] In order to maintain the tube-like form, a hair is tied round the outer extremity of the wisp. The outer part of the hair is placed in contact with moistened gauze, which further increases the syphon action.

Resorbent Tubes: Disadvantages.—Capillary-syphon drains being inefficient for the drainage of pus, something else is required. Tubes other than capillary answer, if suitably placed. India-rubber tubes are employed by most surgeons; and objections to their use have already been stated. Recently, Neubauer introduced what he called "resorbent tubes", which were drilled out of horse and ox bones, and then decalcified and carbolised—their object being to act as drains, and then to yield to absorption. In several cases in which they were used, they disappeared in a few days—two to five. These tubes, therefore, had one of the objections which pertained to the carbolised catgut drains, that of disappearing too soon. They acted during the period that blood and serum required to be drained, and disappeared before pus was likely to be formed. They only did the work which the capillary syphon drain could do a great deal better. Even had they been efficient, their price was such as to preclude their general application: when six were bought, they were obtained at 1s. 3d. each.

Drainage-tubes of Chicken-bone.—The principle of using a tube which would serve its purpose as a drain, and then become absorbed, was excellent, provided this could be carried out practically. What was wanted was a tube which would remain in the tissues, as a drain, for eight or ten days; and which, at the same time, would be reasonable in price. It was determined to set about finding this. Instead of being at the expense of drilling tubes out of bone, it was thought that nature might undertake the duty for us. The hollow bones of birds and some animals could be easily converted into tubes. After examining and experimenting with the tibiæ and femora of many birds and animals, it was seen that the tibiæ and femora of the domestic fowl were the most suitable as to length and calibre. It was also found that the cooking necessary for preparing the fowl for table-use in no way impaired the value of the bone. This at once reduced the expense of the material, as an abundant supply of chicken-bones, previously regarded as refuse, could be obtained in every large hospital. The patients made their repast upon the chickens, while their tissues consumed the bones.*

Preparation of Drainage-tubes of Chicken-bone.—The method of preparation is as follows. The tibiæ and femora are scraped and steeped in hydrochloric acid and water (1 to 5), until they are soft. Their articular extremities are then snipped off with a pair of scissors; the endosteum is raised at one end, and pushed through to the other extremity, along with its contents. They are then reintroduced into a fresh solution of the same strength, until they are rendered a little more pliable and softer than what is ultimately required (as they afterwards harden a little by steeping in the carbolised solution). When thus prepared, they are placed in a solution of carbolic acid in glycerine—1 to 10. They may be used at the end of a fortnight from the time of introduction into the glycerine solution. Holes may be drilled in them with a punch, or clipped out with scissors.

Physical Properties of Drainage-tubes of Chicken-bone.—Tubes are thus formed, having the following physical properties. They are semi-transparent, pliable, and elastic, capable of retaining for some time their form under the weight of thick flaps. The tibiæ make the longer, the femora the wider tubes. The length and width vary considerably, the longest being a little over three inches, the widest being over half an inch.

The Advantage of threading Drainage-tubes with Hair.—Before describing their behaviour in the tissues, it may be well to remind you that these tubes are always threaded with hair before they are introduced into fresh wounds. Any kind of drainage-tube introduced into a fresh wound is apt to become blocked with blood-clot. Surgeons have been in the habit of removing drainage-tubes, cleaning them of the clot, and reintroducing them. The reintroduction irritates the wound, and at times sets up fresh bleeding. Lister, taking advantage of the shrinking of the blood-clot, left the tubes undisturbed, stating that space sufficient was left between the blood-clot and the tube to insure drainage. This has not always been found sufficient. To obviate the blocking of the tube, it is threaded with hair, which sheds the blood and serum of the first few days; after which, the hairs, being no longer of use, are removed, leaving the drainage-tube perfectly patent. If it be preferred, part may be removed at the first, and part at a subsequent dressing. In the case of the chicken-bone drain, the hair helps to maintain the calibre of the tube during the first few days, especially where the dressings might exercise pressure. The action of the hair as a capillary syphon is in no way impaired, but rather improved, by being introduced into the tube.

Duration of Chicken-bone Tubes in the Tissues.—Out of one hundred carefully recorded observations, the average duration of the chicken-bone tubes was something over eight days.

Chromicised Chicken-bone Tubes.—If the surgeon would like a decalcified tube which would resist the action of the tissues for a longer period, he can secure this by steeping the chicken-bone tubes in a chromicised, instead of a carbolised, solution. Some such have resisted the action of the tissues from a fortnight to about three weeks. These chromicised tubes are, however, seldom used, because our fresh wounds rarely require drainage for so long a period.

Are these Decalcified Chicken-bone Tubes absorbed by the tissues?—Some surgeons seem to believe that these tubes are not absorbed, but that they are simply dissolved, as they would be were they immersed in a quantity of blood-serum or pus, kept at the temperature of the human body. That this is not so, the following facts will show. The tubes do not disappear, except when in contact with living tissue in a wound in the soft parts. When they are placed in the midst of a slough, they soften; but there the action ceases—they do not erode. Tubes have been placed in osseous cavities not lined with granulations, from which putrid necrosed bone have been removed. There they have remained for weeks bathed in pus, which emanated from the neighbouring tissues, and they have undergone no other change than that of softening. On one occasion, a tube was placed in a collection of serum resulting from an injury over the muscles of the back. The cavity containing the serum filled rapidly after being emptied, so that the tube was only in

* These tubes were shown to the Pathological and Clinical Society of Glasgow at its meeting on the 10th February, 1880, and were noted in the BRITISH MEDICAL JOURNAL in due course.

contact with the living tissues for a very small part near the skin. This small part was eroded, while the remainder, steeped in the serum, was only softened at the termination of the tenth day. A puncture was then made in the most dependent part of the sac, the drainage supplied being so free as to permit the coalescence of the sides of the cavity, when the tube, which had not hitherto undergone absorption, became absorbed in four days. In another case, there was a slight depression in the limb of a patient, at the bottom of which a granulating surface existed, which discharged pus. On this granulating surface, a small portion of drainage-tube was laid. It was found that the tube was covered with pus after the lapse of six days. The tube generally was softened; but the only part which was eroded was that which lay on the granulating surface. These illustrations are sufficient to show that these tubes do not disappear by the chemical action of the secretions, kept at the temperature of the human body; but that they must be placed in contact with living tissue before they disappear, the leucocytes absorbing them.

In order to aid the observations of the behaviour of carbolised chicken-bones while in contact with the tissues, a small part of the tube was made to project beyond the lips of the wound. By-and-bye, this projecting portion was eaten through, and then dropped off; while the tissues closed over and absorbed the remainder. Tubes have been inserted into abscesses from which the pus has been thoroughly evacuated. When next looked at, fourteen days later, the portions of the tubes which projected from the wound were found detached, lying in the former opening; while a white ring, enclosed in granulation-tissue, marked the seat of the decalcified bone; and, finally, the epithelium covered both from sight. As a rule, however, especially when the tubes were originally threaded with hair, their calibre generally diminished, from pressure on their walls and from the penetration and coalescence of the tissues through the apertures made in them; so that the decalcified tubes, having served their purpose, were slowly removed by molecular activity. The tissues have in this way, so far, the control of their drainage. The greater the normal molecular activity, the more quickly will the wound heal, and the more quickly will these tubes be absorbed; the weaker the vitality, the longer will the healing process take, and the longer will the drainage-tube remain.

Button and other Sutures.—Regarding button-sutures, you are aware of the various kinds already in use. The objection to these is, that they have one aperture in the centre, through which a wire is drawn, and which is then fixed to a catch on one or other side of the button, thereby tending to tilt the button sideways, and so bruise the tissue with its border. This can be obviated by using the button which I show you, and which is in constant use in my wards. It has a couple of apertures, placed very near to one another in the centre, and a double thread is brought through these apertures and tied—so that the pressure comes from the centre of the button, and the wires or threads may be tightened or relaxed without tilting the edge. They are easily adjusted. They can be made in a few seconds by using a sharp-pointed pair of scissors. Lead has generally been used for buttons, on account of its pliability. Block-tin may be had sufficiently pliable, and it is free from the production of black deposits, to which the lead gives rise. Chromicised catgut may be used with these buttons, one end of the double thread being tied into a loop—so that it may be opened to permit tightening or relaxation, as the case may require. It becomes softened and absorbed when the buttons become loose. The edges of the wound are generally brought together by several deep sutures of chromicised gut, with a number of stitches of carbolised gut between; the latter absorbing in a few days, the former about the end of a fortnight.

Conclusion.—In conclusion, gentlemen, you will perceive that our aim is to place in wounds substances which, while effecting the purpose for which they were introduced, will yet produce no irritation, and will permit themselves to be absorbed in due course; so that, once having dressed a wound, we may not be forced to open the dressings for the purpose of readjusting the material employed. We aim at being able, after an operation, to judge of the character of the wound; make provision for its probable wants; and, while the patient is yet under the influence of the anæsthetic, apply a dressing which will remain untouched until the wound is healed, or, at least, well on its way towards being healed. By this means, the healing will take place more rapidly, and the patient will be relieved of much annoyance and pain. An accurately recorded rectal temperature will be a sufficient index of the constitutional condition of the patient; while a watchful eye on the dressings, to insure that discharge does not penetrate them, will secure the safety of the wound. If there should happen to be a discharge of blood during the first forty-eight hours, sufficient to stain the external dressing, the dressings are reapplied; and the opportunity is taken of removing the hairs from the tubes—unless chromicised catgut be used as a substitute. If there be no such discharge, the dressings are left on till the end of the first week; they are then opened, the wound inspected, the hairs removed, and the dressings reapplied. At the end of a fortnight, the wound is looked at for the second time; and, as a rule (in fresh wounds), it is found healed. You see excellent examples of this in the two excisions of the mammæ, in which the whole axilla had to be cleared out; and, in one of them, a large portion of the pectoral muscles had to be removed, as they were infiltrated with caseous deposits. These were looked at for the first time a week after the operation, and found almost quite united; the hair was withdrawn, and the dressings reapplied. At the end of a fortnight, they were looked at a second time, found firmly united, and the drainage-tubes absorbed. Again: in that Carden's amputation in 29 Ward, the same thing has happened; it was all but healed at the end of a week, and firm at the end of a fortnight. There was not a drop of pus from any of them.

HARVEIAN LECTURES

ON THE

PROGNOSIS AND TREATMENT OF CHRONIC DISEASES OF THE CHEST IN RELATION TO MODERN PATHOLOGY.

Delivered at the Harveian Society of London.

BY JAMES E. POLLOCK, M.D., F.R.C.P.,
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LECTURE III.—(*Concluded from page* 149.)

CAN we promote the healing of cavities? This is an important question, and is only part of another—Is phthisis ever curable?

The chronic single cavity, with sufficient communication with a bronchial tube, is, perhaps, the only variety which we could expect to close up and cicatrise.

The conditions under which it formed were necrosis of certain indurated products in the lung, tubercular or inflammatory, the result of compression and strangulation of the blood-vessels. Caseation and fatty degenerative changes followed, and hence the cavity.

The primary condition necessary for its closing or undergoing changes favourable to contraction, is a restoration of the circulation around it to a healthy state.

Fibroid changes in the neighbourhood almost always exist, and, being of low vascularity, oppose the healthy nutrient changes desired. On the other hand, they bound and limit cavities, and prevent their extension; they favour contractile processes, and, if the neighbouring lung-tissues be supplied with a vigorous nutrient circulation, may assist in the ultimate closing of the cavity. Another agent is found in the expansion of the healthy air-cells in the neighbourhood of the injured part; a very common condition, as we know.

We arrive then at this proposition: that when a cavity has become chronic, is cleared out and ceases to extend, every means tending to invigorate a healthy circulation in the neighbouring part of the lungs, and to expand its cells, would assist in its closing; possibly in its cicatrisation. I need not say that we know that such cicatrisations are often found. Now have we any such agents?

Healthy, invigorating exercise, increasing expansion of the chest in all its movements, is among the first of these.

Reading aloud, active out-of-door pursuits, athletic exercises (guided by medical advice), arm-movements, especially adapted to expansive action of the upper ribs, must forward healthy enlargement of the chest-walls. To the same end, the bracing application of cold to the chest-walls by daily cold sponging would minister. Singing, and, in cases not hæmorrhagic, the moderate use of wind-instruments might be advised.

The use of the compressed air-bath may also assist, and of this I hope to be able to record some results, as we have fitted such a bath for use at our new hospital at Brompton.

Climatic influences which tend to expansion of the lung, are important agents in cases of chronic cavity, which we may hope to assist in closing. Elevated positions, with diminished atmospheric pressure, may assist, and especially the bracing influence of cold air. It has always seemed to me that the danger most frequently met with in practice in sending such patients to elevated positions is hæmoptysis, of which I have known many examples; and it will be well to remember this caution, and to avoid sending those who are liable to this symptom.

While we are considering the interdependence of local and general symptoms, it may be well to speak of antiseptic agents applied directly to the lung. In cases of empyema, we are aware of their value.