

## AN ADDRESS ON THE CATGUT LIGATURE.

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GENTLEMEN,—In thanking you for the great honour which you have conferred upon me by my election to this chair, I do so with a peculiar feeling of gratitude, because I am well aware that my personal share in the proceedings of the Society has not been such as to entitle me to hope for so great a distinction at your hands. I can only strive to discharge to the best of my ability the important duties which your kindness has imposed.

In considering the choice of a subject for the inaugural address which is expected from your President, I have felt myself precluded from presenting a summary of the labours of the Society in the past, or from tendering advice as to its conduct in the future; and, after consultation with some influential members of the Council, I have decided to bring before you this evening a special subject, which will, I trust, be thought not unworthy of the occasion, inasmuch as, while it is still in an unsettled or transitional state, it is full of interest for every practical surgeon, and at the same time, in some of its aspects, well deserves the attention of the pathologist and the physician. I refer to the catgut ligature. In adopting this course, I feel it needful to crave your indulgence; for the subject is a large one, and, in order to do it anything like justice, I shall have to trespass for a considerable time on your attention.

The catgut ligature has in some respects exceeded my original hopes. I feared that its advantages would be limited to wounds in which putrefaction was avoided; and that, if septic suppurative took place in a wound in which it was employed for securing the vessels, the ligatures would, sooner or later, come away like little sloughs. Such, however, has not proved to be the case. Whatever be the progress of the wound, we never see anything of the catgut; so that even surgeons who have not adopted strict antiseptic treatment have been led to employ the new material in ordinary wounds. Under other circumstances, however, the catgut has often led to disappointment. We hear of cases in which Cæsarean section has been performed, and all has gone on well until the knots of the catgut with which the uterine wound was secured have given way, and the patient's death has been the result. Again, in ligature of large arterial trunks in their continuity, several surgeons have met with bitter disappointment; the case ending in disaster from secondary hæmorrhage, or the treatment proving abortive through the channel of the vessel becoming opened up again at the site of the ligature. Hence many surgeons have been induced to return to silk, even though using strict antiseptic treatment—rendering the silk aseptic by steeping it in suitable lotion, and cutting the ends short. This practice has, however, by no means proved uniformly successful. As an instance of unsatisfactory result, I may mention a case which was recorded by Mr. Clutton in the last volume of our *Transactions*. He tied the external iliac artery under strict antiseptic precautions, and the wound healed within a week; but, as I learned from a letter which he was good enough to send me at the time, "six weeks after the operation a little blister formed, and fluid began to escape, forming a small scab; and in three months the loop which had been placed around the artery came away". Such a result was not at all surprising to me, seeing that what induced me to try the animal ligature, was the discovery of a small abscess about the remains of a partially absorbed silk thread which I had applied in the same manner as Mr. Clutton, and, as it so happened, to the same artery.\* It can hardly be doubted that suppuration proceeding from the immediate seat of the ligature must be a source of danger. As an illustration of the mischief which a ligature of ordinary material may do, I may mention a case of goitre in a young woman on whom I operated on the 28th of January last year. It was of moderate dimensions; but the effect on the respiration was so considerable, that I determined to remove it, following Dr. Patrick Heron Watson's plan of preliminary

\* See Observations on Ligature of Arteries on the Antiseptic System, in the *Lancet* April 3rd, 1869.

deligation of the thyroid vessels circumferentially to the tumour. If this be effectually done, the operation is bloodless; so that, as the laryngoscope applied by Dr. Felix Semon, who had recommended the case to my care, showed that the anterior wall of the trachea was pressed backwards considerably by the growth, I adopted a measure which I believe would in all cases of removal of the thyroid prove advantageous; namely, I divided the tumour in the first instance in the middle line, so as, in the event of adhesion to the trachea, to be able to remove the two halves of the growth at leisure—dissecting it off from the trachea more or less completely as may be desired, leaving some portions at the adherent parts, so as to avoid the deadly risk of perforation of the air-passages. But, in order that the circumferential ligature of the thyroid vessels may be secure, it is essential that the material should be very strong, so that the tissues round about the tumour, including the vessels, may be thoroughly tightened up. I possessed no catgut which I felt was strong enough to bear the full strength of my hands, and therefore I was compelled to use the hempen ligature—after, of course, carefully rendering it aseptic by means of the carbolic lotion. Six of these hempen ligatures were used—three on each side. During the first eight days, everything went on in a typical fashion according to the antiseptic method. There was a small serous effusion, rapidly diminishing; and we looked to the wound being healed in a few days more. But on the ninth day there was seen to be a little something of purulence mingled with the discharge; and the pus afterwards became thicker, though always in small quantity, and could be pressed out from each side; in a month, one of the hempen ligatures made its escape. Six days later, four other of the hempen threads came away, altogether unaltered, as may be seen on one of the cards on the table where I have exhibited them. I submitted them to careful examination. They had a sour odour, and, applied to litmus-paper, gave an acid reaction; that is to say, the natural alkaline condition of the blood-serum had been changed to acidity by some peculiar species of fermentation. On examining them with the microscope, I found the interstices of the threads of the hemp loaded with a little organism, to which I believe I happened to be the first to direct attention as to its mode of growth,\* and to which I gave the name of *Granuligera*, occurring in groups of two, three, four, and so forth, as distinguished from the chains of ordinary bacteria, and of which one form at least has been since shown by Mr. Cheyne to occur very frequently in cases treated antiseptically, without any interference with aseptic progress. I found that the interstices of the threads of the hemp were loaded with these little micrococci. It so happens that I have had the opportunity within the last few days of obtaining a sample of these micrococci, thanks to Mr. Cheyne's kindness. He brought this flask of a pure and perfectly transparent infusion of meat to a case which I had operated on a fortnight before by excision of the ankle. The skin had been unbroken, so that I was able to operate antiseptically, and the case pursued a perfectly typical course. The wounds, which were left gaping at the time of the operation, were filled with blood-clot, which remained unaltered in appearance, though undoubtedly organised by that time, more or less. A little piece of the blood-clot from one of these wounds was introduced, with careful antiseptic precautions, into the flask of clear fluid; and you see it is now turbid, and there is under the microscope on the table a specimen of the little organism to which the turbidity is due. But though, under ordinary circumstances, these micrococci may be present, as Mr. Cheyne has abundantly shown, and as the excision of the ankle I have just referred to illustrates, without causing any evil, yet there may be circumstances in which they may prove mischievous; and the case of goitre which I have been relating appears to have been one of these. The micrococci developing for a protracted period in the interstices of the hempen ligature produced an acid fermentation of the serum in its most aggravated form. The acid serum became a cause of irritation; and thus the ligatures, which otherwise, being unirritating in their own substance, might have become encapsuled, and in due time absorbed, became causes of suppuration. One of the six ligatures still remained unaccounted for. In due time, we sent the patient home with a small sinus remaining, a little pus always discharging from it; but it was not until the middle of September that the last ligature came away altogether unaltered. Now, gentlemen, there is no doubt whatever that, if I had had catgut which I could have trusted for the operation, the catgut ligatures would have been disposed of within two or three weeks, and the healing, instead of requiring eight months, would probably have been completed in a fortnight. Here, then, we have an illustration of the great disadvantage which may arise, even under antiseptic treatment, from the use of the ordinary forms of ligature.

Animal ligatures of another kind have been provided by Mr. Barwell in order to remove these difficulties, namely, strips of the mingled

\* See *Transactions of the Royal Society of Edinburgh*, vol. xxvii, 1875.

yellow-elastic and unstriped muscular tissues which constitute the arterial wall, obtained by cutting spirally the aorta of one of the larger animals. But, though fully admitting the efficiency of these ligatures in his hands, I am given to understand that their form and size render them by no means very convenient; and independently of this, I cannot but feel that it is unsatisfactory, if it can be avoided, to have a special material for this particular object, and that it would be better, if possible, to have the catgut in a thoroughly reliable condition. Catgut, of which I have samples here, is to be had all over the world in abundance. It is beautifully strong and smooth; it is prepared of various sizes, admirably adapted for all the purposes of the surgeon, and is extremely cheap. Wholesale, it is sold at twelve shillings per gross, that is to say, one penny per hank. But, as it comes from the maker, it is entirely unfit for the purposes of the surgeon. However beautiful it is in the dry state, it becomes soft and pulpy soon after it has been placed in blood-serum. In one of these glasses is a piece of unprepared catgut, which was placed in warm serum this morning, obtained from the blood of a cow, and, within half an hour, it was in the condition in which it is at the present time—swollen, soft, and pulpy. A knot tied upon it would hold as little, or scarcely better, than would one on a piece of the intestine from which the catgut is derived. It is essential, in order to fit the catgut for the purposes of the surgeon, that it be altered in its physical constitution so as to be no longer liable to this softening effect by the serum of the blood. It is a remarkable circumstance, that the blood-serum softens catgut more than even water does. It might have been expected, *a priori*, that a solution of a colloidal substance like albumen would have been much less disposed than water to permeate and soften an animal-tissue like catgut; but it is otherwise, and, therefore, we cannot test the trustworthiness of catgut by steeping it in warm water, as I formerly used to do. In order to be sure that a given specimen of catgut will answer the purpose in so far as the knot is concerned, that it shall not slip, it is useful that we should steep the catgut in blood-serum, a somewhat troublesome process, as it involves sending to a slaughter-house for blood.

The method of preparing catgut which I published long ago answers the purpose very well, even for the ligature of arteries in their continuity, provided certain conditions be complied with; such at least is my own experience. This, indeed, has not been very extensive, but it has been sufficient to deserve consideration. I have tied altogether nine large arteries in their continuity with prepared catgut. Of these, one was a case of ligature of the carotid in a young woman, aged 22, with a pulsating tumour below the angle of the jaw, in the situation of carotid aneurism, and with all the symptoms of that disease. The application of the ligature reduced to a certain degree the pulsation and the dimensions, but the further cure which we hoped for did not take place. She left the hospital with a pulsating tumour, and I heard only yesterday, from the medical man under whose care she is in Scotland, that this tumour, for which I tied the carotid artery in 1874, still exists as a pulsating tumour, if anything rather on the increase. But though, as regards the cure of the disease, the ligature was unsatisfactory, nothing could be more beautiful in its effect as respects the healing of the wound without suppuration, and the permanent obstruction of the vessel at the seat of ligature.

A case of traumatic arterio-venous aneurism of the temporal artery, in a young man lately under my care in King's College Hospital, may be mentioned in this category, partly because the greatly dilated condition which the naturally small artery had assumed brought it up towards the dimensions of a large trunk, and partly because the concurrent ligature of the largely dilated veins would, without antiseptic means, have been justly regarded as of considerable danger. The others were all cases of ligature of the femoral. Six were popliteal aneurisms, four of which presented nothing deserving of special remark; one was a diffuse aneurism extending up to the junction of the lower and middle thirds of the thigh; one was an enormous diffuse aneurism reaching up nearly to Poupert's ligament. It was necessary for me to tie the femoral artery about the situation of the ordinary origin of the profunda, and even there my incision opened into the aneurismal clots. The last was a case of a large arterio-venous aneurism of the upper part of the femoral, of idiopathic origin. This case was of such special interest that I hope, on a future occasion, to make it the subject of a paper before this Society. In all these cases except two, the catgut ligature prepared by the old method was employed, and in all these nine cases the result was satisfactory, and recovery perfect, except as regards the poor young woman who has still the pulsating tumour in her neck.

As regards the mode of applying the ligature, I have always used a single reef-knot with short cut ends, tying it sufficiently tightly to cause the giving way of the internal and middle coats. This latter point is

not, indeed, essential; as I long ago surmised, and as Mr. Barwell's experience has demonstrated. But if, as in the case of catgut, the form of the ligature admits of it, the injury done to the deeper tunics is, I believe, advantageous, by leading to a salutary corroborative process of repair.

Why, it may naturally be asked, has my own experience been more satisfactory with the catgut ligature than that of many other surgeons? There are, I believe, two reasons for this. One is, that I have never ventured to tie an artery of considerable size in its continuity, without having taken pains to ascertain that the catgut was of thoroughly reliable material; and the other reason is, that I have adopted strict antiseptic means of treatment, not only during the earlier stages of the case, but to the last. So long as any part of the wound remains unhealed, antiseptic treatment of the strictest kind ought, I believe, to be employed. Even though the sore may seem to be superficial, there may still exist a sinus leading down to the site of the ligature; and, if ordinary treatment, as distinguished from antiseptic, be employed, down this sinus the septic process may advance and invade the ligature, and lead at last to disaster from hæmorrhage. I know that this has actually taken place.

But, although the catgut prepared after the old method answers very well if it be of proper quality, there is this great objection to this method: that it requires a long time in order to produce the requisite quality. At least two months are needed to make the ligature at all trustworthy. It is better at the end of six months, and still better at the end of a year. I possess catgut prepared in this way twelve years old. I have brought here a sample of such catgut, which has been steeping in warm blood-serum since this morning, and it will be seen that it remains translucent, and is comparatively firm, instead of being opaque and soft, like the unprepared catgut in the same serum.

Now, the length of time that the present method requires is a very serious objection. It makes the surgeon who has not prepared the catgut for himself, and kept it for a long time, at the mercy of the person who supplies it; and the person who supplies it, not being aware of the enormous importance of the question of time, if he happens to run out of that which has been long prepared, will sell what has been only a short time in the preparing liquid, and is, in consequence, altogether untrustworthy. A case illustrating this point occurred last year in my practice at King's College Hospital. A patient was admitted who had met with a severe wound on the ulnar side of the forearm at the anterior aspect. The ulnar artery had been divided. This had been secured by my house-surgeon. He had also tied with catgut the corresponding ends of the various tendons that had been severed. But, when I saw the patient next day, I found that he could not feel with his little finger and the adjacent side of the ring-finger; and, therefore, it was evident that his ulnar nerve also had been divided, and my house-surgeon had not thought of attending to the ulnar nerve. I therefore cut the stitches in the skin, and proceeded to explore the deeper parts of the wound, in order to find the ends of the divided nerve, and tie them also together with catgut; and I found that all the catgut sutures with which the ends of the several tendons had been tied together were lying absolutely loose; the knots had slipped within the twenty-four hours, and yet this catgut had been supplied by one of our ordinary instrument-makers. He had sent us what had not been sufficiently long prepared. I took care to use proper catgut for the ulnar nerve; and the patient left the hospital with restored sensation in the fingers. The length of time that it requires is, therefore, an exceedingly serious objection to the present method of preparation; and one great object which I have had in view in a series of experiments on this subject, with a view to improving the preparation of the catgut ligature, has been to devise a means, if possible, of preparation within a short time. These experiments—it may seem almost ludicrous to say so—have occupied two years of my leisure time in the past, some time ago; and, after being interrupted by an accidental circumstance, have been continued in a more desultory manner since; but at length I feel myself justified in bringing before you a new mode of preparation, by which the catgut can be prepared in a short period, and, at the same time, in a perfectly reliable condition.

But, before I allude to these experiments, which I must endeavour to do in a short compass—I should weary you if I were to bring a large proportion of my facts before you, though I may say, out of the hundreds of experiments I have performed on the subject, I have never performed one which has not added something to my knowledge of it—before referring to these experiments, I wish to say a few words as to what catgut is. Catgut, as you are all doubtless aware, is prepared from the small intestine of the sheep. The gut is treated in what seems an exceedingly rude manner for so delicate a structure. It is scraped with some blunt instrument, such as the back of a knife, over a board; and by this means, as the people express it, the

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 sub-mucous 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

### SOME POINTS CONNECTED WITH THE TREATMENT OF WOUNDS.

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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