AN ADDRESS ON THE CATGUT LIGATURE.

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I NEED hardly say that this mode of preparation (gradual "seasoning", as the result of mere lapse of time), interesting though it is, would not be satisfactory; it would only have, in a more aggravated form, the inconvenience of the extremely long period which our old method requires. Besides that, it by no means fulfils all the conditions that are required for a perfectly satisfactory state of the catgut for surgical purposes. These conditions I will now mention. In the first place, I have spoken of a short period of preparation. This is very desirable. Then it is essential that the catgut should have proper strength, so as to bear any reasonable strain that the human hands can put upon it, in the thicker forms; as when used, for instance, in such cases as the circumferential ligature of the thyroid vessels in the removal of a goitre, or for securing the pedicle in ovariectomy. And it is not sufficient that it should be strong to start with; it is easy to get catgut strong in the dry state; it is necessary that it should be strong after steeping in blood-serum for a while. Take, for example, the case of tumour of the thyroid. I employed six ligatures, and in a former case, where the tumour was larger, I thought it prudent to pass as many as eight, so as to subdivide more the mass that had to be tied; but it is not convenient to tie each of these ligatures as soon as it is passed; and the process of passing takes a considerable time. Now it would be a very sad thing if the residence of the catgut among the tissues soaked with serum for a few minutes, or even a quarter of an hour, should render the catgut so soft that it should give way when we put the strain of the hands upon it. That, then, is another point essential, if the material is to be useful for all the purposes for which it is desired. Then, again, it is necessary that a knot tied upon it should hold with absolute security, not merely in the first instance, but after soaking for an unlimited time in blood-serum. It is further needful that it should not be too rigid; for, as we shall see immediately, it is possible for catgut to be over-prepared; in which case it may remain almost like a piece of wire among the tissues, and ultimately, perhaps, come away by supuration in consequence of the mechanical irritation which it produces. But while the animal juices must be able to soften it sufficiently to render it mechanically unirritating, yet, on the other hand, it will not do for it to be too rapidly disposed of by absorption. If it is to do duty for the ligature of an artery in its continuity in the immediate vicinity of some large branch, it must remain for a considerable time of good strength, unabsorbed; and, when it is at length absorbed, it is desirable that it should be removed in such a manner that, while it is reduced in thickness, it should still, as long as any of it remains, retain its tenacity.

Now, these are a series of conditions which, I assure you, it is not easy to fulfil completely. I have in various experiments complied with some of them easily enough, but failed in others. Sometimes I have succeeded with all but one, and one has baffled me. I have tried various materials, as you will naturally suppose. One substance that suggested itself was tannic acid, so as to convert the fibrous tissue of the catgut into leather. I succeeded well enough in some respects with tannic acid, applied in different ways; but in one respect I did not succeed. I have not obtained, by means of tannic acid, a kind of catgut that is not too speedily absorbed. Even a piece of kid-leather, cut into a suitable shape for sutures, and rendered aseptic, became too rapidly absorbed. Chromic acid was another agent which I very naturally tried on account of its well known effect in hardening tissues. Chromic acid alone does not work very well; but I found that the addition of some other substances to it aided its action very greatly. By adding, for instance, to the watery solution, a little glycerine, thus producing a reducing action on the chromic acid, we get a different sort of liquid, which acts much more energetically on the catgut. I was highly delighted with the results of the action of this mixture of chromic acid and glycerine; and just at this time it happened that Mr. Oliver Pemberton of Birmingham applied to me for

a piece of catgut, for the purpose of ligaturing the external iliac artery in a remarkable case of three aneurisms in one limb—two in the femoral artery and one in the popliteal. I thought I could not do better than send him a piece of my recently-prepared chromic catgut. I did so; and a month afterwards he wrote to me, saying that nothing could be more satisfactory than the result. He had operated antiseptically; the wound had united by first intention; and, so far as the case could go well, all had gone well. There was, indeed, gangrene of the lower part of the leg, which Mr. Pemberton had predicted would occur, in consequence of the existence of four successive obstructions in the course of the arterial channel; viz., the ligature and three solid aneurisms. But the case, under proper management, was doing well. Four weeks later, however, Mr. Pemberton wrote to me again, telling me that, soon after his last report, the patient had begun to show signs of suppurating about the seat of the wound. After a while the abscess opened in the cicatrix, and one day the ligature which he had placed on the artery was found lying unaltered on the granulations.* It is now on one of the cards before you—an over-prepared ligature, which had come away, rigid and wire-like, making its way out, as a piece of glass might have done, by mechanical irritation. This opened my eyes for the first time to the possibility of having catgut over-prepared. This over-preparation by means of chromic acid is, I understand, to be found illustrated in a large German school at the present time. I have been told by an American physician, who has lately been in London after spending some time at that school, that the catgut ligatures come away from all wounds to which they are applied in that clinique. They count the ligatures as they put them on, and invariably see them all before the case is done with. The catgut has been over-prepared.

It is by means of chromic acid, however, that I have at length arrived at a result which appears to satisfy all our conditions. But before speaking of the new method, I wish to say a few words more with regard to the old. To what is it that it owes its virtue? In this bottle is some catgut which has been nearly ten months in our old preparing liquid—namely, one part of carbolic acid which has been liquefied by means of water, to five parts of olive oil. In this other vessel again we have catgut which has been the same length of time in a solution of carbolic acid in water. Water will only take up one-twentieth part of its weight of carbolic acid; but the effect produced upon the catgut by the watery solution is very much greater than that brought about by the four times stronger oily solution. In the former case, as you can see, the catgut is almost black, a sort of purple-black; while the other is comparatively pale, very little altered from its original colour. This circumstance shows two things. In the first place, the effect of the watery solution of carbolic acid upon the catgut explains the efficacy of the water in our old method. It is the watery solution of carbolic acid in the liquid of the old method that is the effective agent. But in the second place we see that, when the watery solution is mixed with oil, the fact that it is so mixed limits and checks its operation. If catgut is kept in the watery solution only, there seems to be no limit to the degree of continuous preparation of the gut—so that it becomes more and more dark in colour, and more and more difficult of absorption by the tissues. It is otherwise when the watery solution is blended with the oil. Though the process does go on for many months, there comes a time when it comes to a stand-still. You need not fear that catgut prepared by the old plan is ever over-prepared. There is a specimen on the table, which, at the end of twelve years, is as limp, after steeping for a while in blood-serum, as it would have been at the end of a single year. Therefore we possess in the carbolic oil a means of checking any mode of preparation that we may adopt, keeping it from that time forward not materially further prepared; while, at the same time, the large proportion of the carbolic acid to the oil (one to five) ensures the catgut being maintained perfectly aseptic.

The method of preparation which I have now the honour to bring before you is the following. I dissolve one part of chromic acid in 4,000 parts of distilled water, and add to the solution 200 parts of pure carbolic acid, or absolute phenol. In other words, I use a 1 to 20 watery solution of carbolic acid—only that the carbolic acid is dissolved, not in pure water, but in an exceedingly dilute solution of chromic acid. But minute as is the quantity of the chromic acid, it exerts, when in conjunction with carbolic acid, a most powerful effect upon the gut. The first effect of the addition of the carbolic acid to the chromic solution is to change its pale yellow colour to a rich golden tint. But if the liquid is allowed to stand without the introduction of the catgut, it changes in the course of a few hours to a dingy reddish brown, in consequence of some mutual re-action of the two acids; and a considerable amount of reddish-grey precipitate is formed. If, however, catgut about equal in weight to the carbolic acid is added as soon as the ingredients are mixed, the

* For an account of this case by Mr. Pemberton, see *The Lancet*, Aug. 4th, 1877.

liquid retains its brightness, and the only change observed is a gradual diminution of the depth of the yellow colour; the precipitate which, I presume, still occurs, taking place into the substance of the catgut. As soon, therefore, as the preparing liquid has been made, catgut equal in weight to the phenol is introduced into it. If you have too large a proportion of catgut, it will not be sufficiently prepared; if you have too small a quantity, it may run the risk of being over-prepared.* At the end of forty-eight hours, the chromic element of the liquid has nearly spent itself, and precipitation is complete. The catgut is then taken out of the solution and dried, and, when dry, placed in 1 to 5 carbolic oil: it is then fit for use. I have here a sample of catgut prepared by this method. Although it has been steeped in warm blood-serum since this morning at eleven o'clock, it is still translucent and firm without being rigid, and a reef-knot tied upon it holds with the most perfect security.

The strength of the catgut depends upon different circumstances. In the first place, sheep differ as to the strength of their intestines; and the catgut-maker, if he understands his business, will insist upon having his raw material of a proper kind. In the next place, the intestines must not be allowed to putrefy—they must be used when quite fresh. For these things you must, of course, rely upon the maker of the catgut. In the next place, the preparing liquid causes a certain amount of softening of the catgut, and if it is introduced in loose hanks, this will tend to produce a little uncoiling of the twisted cord, and a still greater degree of uncoiling will take place during drying. It is of very great importance that this should not occur, because it involves weakening of the thread, and that in different degrees in different parts; and this may lead to the gut giving way when you subject it to a strain. The catgut, then, should be prepared on the stretch, both when it is put to soak and when it is put to dry.

I need not enter into the mode in which this can be done by the manufacturer. I may only say this, that the surgeon who wishes to prepare it himself may do it in different ways. For instance, he may take two large test-tubes, one a little larger than the other, and he may wind the catgut on the smaller tube, fixing one end by sealing-wax, winding it round, and then bringing it up again, and fixing the other end with sealing-wax at a higher level than the liquid will reach, putting sufficient liquid into the larger test-tube, and introducing the smaller test-tube with the catgut wound round it, with a little shot to keep it down in the liquid. After forty-eight hours, he takes out the smaller test-tube, and leaves it till the catgut is completely dry. I merely mention this as an illustration, and also as furnishing a hint to some surgeons in private practice who may desire to prepare the catgut themselves. Or a couple of gallipots, one larger than the other, will do just as well. But, as I have already said, the principal uncoiling takes place during drying; and for all ordinary purposes a sufficiently good article is got by putting the catgut loose into the liquid, and making it dry on the stretch by tying the ends of each hank to two fixed points in a room.

In the dry state, catgut prepared by this method is as strong as need be. As to strength in the condition after steeping in blood-serum, I confess it is only this very day that I have obtained evidence that catgut thus prepared is really all that we can desire in that respect. The catgut of the hank from which this specimen was taken measured in the dry state $2\frac{2}{3}$ hundredths of an inch in diameter, and broke at 13 lbs. 6 oz. I have found, by experiment, that 10 lbs. is the utmost strain that my arms are able to put upon a cord. Thirteen pounds six ounces, then, is amply sufficient; while, at the same time, the catgut is not at all too large for going into the eye of an aneurism-needle. Having obtained, the other day, some fresh blood of a cow from the slaughter-house, I took some of the serum to-day, and put two pieces of this same hank of catgut in the serum, and I placed it in a stoppered bottle in a warm box at a temperature of 98° Fahr. After more than half an hour, I tested the breaking strain (I must not stop to explain how that is done†); and I found that the breaking strain of the same catgut which in the dry state had broken at 13 lbs. 6 oz., was 11 lbs. 4 oz.; that is, though supplied by the serum, it had only lost in

strength two pounds out of thirteen. I think that is really all that can be desired.

The only remaining condition to be considered regarding the new catgut, is its suitable behaviour among the tissues. Before describing this, I wish to say a few words regarding the manner in which catgut is absorbed. It has been said of late, by various persons, that the catgut is dissolved by the serum. I must confess that this is entirely contrary to my own experience. I have already said that, in order to test the quality of catgut, you must have it steeped in blood-serum. I have tested in this manner catgut prepared in various ways. The serum has sometimes been putrid; sometimes it had no smell at all; and sometimes it had a little odour. This serum has been kept about the temperature of the body; but I have never seen the slightest indication of any chemical solution of the catgut. Then, again, as to the behaviour of the catgut in the body: suppose we use it as a stitch, if the catgut were disposed of as a matter of chemical solution, we should expect that, when it is employed as a suture, and a piece of our protective is put over it, which is always kept moist with serum perpetually oozing from the wound, the outer parts of the stitch, the parts outside the skin, as well as the parts among the tissues, would show signs of diminution. It is never so. The diminution is always absolutely limited to the parts within the tissues. It is still more striking, as was suggested to me by Mr. Cheyne, to consider the case of catgut used as a drain. There its very function is to drain out the serum, and it is perpetually washed with it. You might suppose that a stitch might perhaps become a little dry; but here there can be no mistake: the serum from the wound is perpetually flowing over the gut; yet, as in the case of the suture, we find the diminution of the catgut is absolutely limited to the part within the tissues. This seems to me sufficient evidence that it is not a question of the mere chemical solution of the catgut, but of the disposal of the catgut in some way or other by the living textures.

Now, if we examine catgut in the process of diminution, we find that it may be affected in one of two ways. If it have not been properly prepared, the substance of the catgut becomes converted in the course of a very few days into a soft pultaceous mass, which, when we examine it by a microscope, we see consists of remains of the old cellular tissue of the submucous coat, with the interstices among the fibres filled with cells of new formation. The catgut tissue is infiltrated with young growing cells, and it is obvious it is this infiltration which is the cause of the softening. But, on the other hand, if the catgut is properly prepared, instead of being infiltrated by the cells of new formation, it is only superficially eroded. I have here a pretty example of catgut prepared by the new method that has been served in that way by the tissues. You will see that, at the part which was among the tissues,

In this woodcut, the suture referred to is represented magnified five diameters. Its actual thickness was one-fiftieth of an inch. The part between *a* and *b* is that which had been among the tissues.

there remains a very slender residue of the catgut, all the rest having gone; but that slender residue continued firm and translucent, showing not even a superficial infiltration; in short, having exactly the characters that we desire for catgut required for the ligature of an artery in its con-

* A moderate excess of the liquid, not exceeding twice the prescribed amount, does not produce any serious degree of over-preparation.

† The mode of proceeding was as follows. A piece of steel, of horse-shoe form, is suspended by a ring on the middle of its convexity, so that the horns of the horse-shoe are dependent; these horns being perforated for the reception of a cylindrical bolt of steel, which thus lies horizontally, and can be removed at pleasure. A piece of the catgut having been tied in a double reef-knot, the bolt is partially withdrawn, and is readjusted after the noose of the catgut has been slipped over it. Into the lower part of the catgut-ring thus suspended, is passed the upper end of a pot-hook, to the lower part of which are attached weights approaching what the gut is likely to bear, and also an empty bag, into which shot is poured till the cord gives way. The shot is weighed; and the result, added to the other weights, gives double the breaking-strain of the gut: for, as the cylindrical bolt works with perfect smoothness in its bed, it adjusts itself so as to prevent inequality of strain in the two sides of the catgut-ring, which thus take an exactly equal share in sustaining the weight.

tinuity—namely, that till the last, even though reduced in dimensions, it shall retain some degree of its original firmness and tenacity. We know that antiseptic treatment has shown that a piece of dead bone may be absorbed, provided it be not putrid: the granulations that overlap superficially may, so to speak, erode it. It is not necessary for us now to consider how that is effected; but certainly, in some way or other, the granulations do what mere steeping in serum, whether putrid or non-putrid, never would do. Never, I believe, would the bone be dissolved by the serum. And just as a non-putrid sequestrum is served by the tissues, so is a well-prepared specimen of catgut; it is superficially eroded. I have here a stitch that I removed to-day from a wound made ten days ago—a wound made for stretching the anterior crural nerve, which was stretched, as well as the sciatic, in an aggravated case of sciatica. You may see that, as yet, it shows no signs of erosion. We know by experience that, if it were left three or four more days, we should probably find it eroded, as the former specimen shows; but, until nearly a fortnight has elapsed, erosion does not begin. It then proceeds gradually, and, therefore, the thicker the catgut, the longer is the time required for its complete removal. We may fairly consider that from a fortnight to three weeks is long enough for the persistence of a ligature upon an artery in its continuity. [Three days later I removed two remaining stitches in the case last referred to, and found both of them slightly eroded superficially.]

I have brought with me the carotid artery of the calf in which I first established the fact of the substitution of new living tissue for the dead old tissue of the catgut.* If any gentleman will examine the specimen after the meeting, he will see the ligatures of new formation incorporated with the external cellular coat of the artery. I have been strangely misunderstood as having intended to convey the idea that the catgut, when it becomes organised, comes to life again. Gentlemen, such an absurd notion certainly never entered into my head any more than, when I have spoken of the organisation of a blood-clot, I have meant by that expression to convey the idea that the blood-clot becomes organised by its own inherent virtue. I found the term "organisation" ready to my hand; it was no term of my invention. It was used with reference to lymph. Now pathologists, in speaking of lymph as becoming organised, did not, I suspect, mean by that expression to imply that it was the lymph-substance that had the power of self-organisation, as distinguished from any influence that surrounding tissues might exert upon it. So in the same way the expression "vascularisation of lymph" was used when it was universally believed by pathologists that the blood vessels were formed only as loops from pre-existing blood-vessels. Now-a-days a different view may be taken, but the term "vascularisation of lymph" was employed without any notion that the lymph itself created the blood-vessels. And so when I spoke of the organisation of the blood-clot or of catgut, I never meant to convey the idea that either the one or the other did the work itself. As to the blood-clot, we know that if it remains free from putrefaction among the tissues, it speedily becomes infiltrated with cells of new formation. Whether the white corpuscles originally present in the clot take any part in the formation of these new cells is a question now under discussion, and one, I conceive, not at all prejudiced by the use of the term "organisation of the blood-clot". With regard to catgut, I think if gentlemen would refer to my original paper in the *Lancet*, they would see that I stated very explicitly that new tissue forms at the expense of the old, that the old tissue is absorbed by the new, and that as the old is absorbed, new is put down in its place.

In conclusion, gentlemen, I venture to recommend the new chromic catgut as in all respects deserving of your confidence, and at the same time to thank you sincerely for the patient attention with which you have listened to this address.

* See *The Lancet*, loc. cit.

NATIONAL HOSPITAL FOR CONSUMPTION, VENTNOR.—The annual meeting of the governors was held at the offices, 12, Pall Mall, on Wednesday, February 2nd. In the absence of the president, Viscount Eversley, the chair was taken by Sir Harry Verney, Bart., M.P., vice-president. The report presented recorded a continuance of the efficiency of the institution, and that an increased number of patients had been benefited by treatment at the hospital during the past year. The receipts for the year amounted to £7,216, and the expenses to £7,380. Legacies amounting to £637 4s. 11d. had been received. H.R.H. Prince Leopold was elected president in succession to Viscount Eversley. The medical report was read by the hon. visiting physician, Dr. Sinclair Coghill, and it stated that 598 patients had been treated, the mortality being only 2.8 per cent. The report was adopted, and the meeting terminated with a vote of thanks of the chairman.

A LECTURE

ON

BACKACHE, AND THE DIAGNOSIS OF ITS VARIOUS CAUSES, WITH HINTS ON TREATMENT.

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GENTLEMEN,—The careful study of a particular prominent symptom, with a view to ascertain the various causes from which it may arise, is often of great practical utility. I propose now to make this inquiry with regard to the very common symptom *backache*. A patient comes to us complaining of pain in the back; and, as an essential preliminary to the suggestion of a remedy, we endeavour to ascertain the precise seat, the nature, and the cause of the pain.

I will first refer to the more common causes of backache, and afterwards to those which are of less frequent occurrence.

In the great majority of cases, the pain of backache has its seat in the muscles, and is a simple result of strain or over-fatigue of the lumbar and erectores spinæ muscles and tendons. Everyone must have had personal experience of the pain and soreness resulting from muscular fatigue consequent on any unaccustomed or unusually prolonged or violent exertion or strain. One remarkable feature of the pain which results from excessive muscular exercise is that, while it may continue more or less during rest in bed, it is usually much increased by the first movements after rest, but gradually diminishes after moderate exercise.

While investigating the various causes of muscular lumbago, it is well to bear in mind that standing still is more fatiguing for the legs and the back than walking, and that leaning forward puts a greater strain on the muscles of the back than standing erect. The backache resulting from fatigue of the dorsal muscles is often bilateral, and equally severe on the two sides; but not unfrequently it is confined to one side, or is much more severe on one side. This is accounted for by the common practice of throwing the weight of the trunk, while standing, more upon one leg; the spine being more or less laterally curved, and the muscles on one side, therefore, having a greater strain upon them than those of the other.

A common cause of painful overstrain of the dorsal muscles is an excessive weight in the abdomen, such as results from the advanced stage of pregnancy; an accumulation of dropsical liquid, whether ascitic or ovarian; or an excessive development of fat. It is obvious that the continued effort required to maintain the erect posture with an exceedingly ponderous abdomen must often cause a painful strain of the dorsal muscles.

I do not propose now to discuss the treatment of abdominal dropsy. Pregnancy in due course brings its own natural cure; and an excessive weight of fat may be lessened and regulated by a system of diet which reduces to a minimum the amount of oily, saccharine, and farinaceous articles of food. It happens to me very frequently to be consulted by fat men and women suffering from pain in the back, who come to me under the impression that their pain has its seat in the kidneys. For the permanent relief of these cases, I rely mainly upon the following dietary; and I have received many grateful acknowledgments of the relief thereby afforded.

Diet for Excess of Fat.—*May eat:** Lean mutton and beef; veal; lamb; tongue; sweetbread; soups, not thickened; beef-tea and broths; poultry; game; fish of all kinds; cheese; eggs; bread *in moderation*; greens; spinach; water-cress; mustard and cress; lettuce; asparagus; celery; radishes; French beans; green peas; Brussels sprouts; cabbage; cauliflower; onions; broccoli; sea-kale; jellies, flavoured, but not sweetened; fresh fruit in moderation, without sugar or cream; pickles.—*May not eat:* Fat bacon and ham; fat of meat; butter; cream; sugar; potatoes; carrots; parsnips; beetroot; rice; arrowroot; sago; tapioca; macaroni; vermicelli; semolina; custard; pastry and pudding of all kinds; sweet cakes.—*May drink:** Tea, coffee, cocoa from nibs, with milk, but without cream and sugar; dry wines of any kind in moderation; brandy, whiskey, or gin, in moderation, without sugar; light bitter beer; Apollinaris water; soda water; seltzer water.—*May not*

* If any of the above permitted articles of food or drink should be found to disagree, they are of course to be avoided.