CLINICAL LECTURE

ON

PERMANENT SUBCUTANEOUS SUTURE OF THE PATELLA FOR RECENT FRACTURE.

Delivered at University College Hospital.

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GENTLEMEN,—In the last four cases of simple transverse fracture of the patella which have come under my care I have employed a method of suture which has yielded such excellent results that I venture to think it deserves a wider trial, and also that I should draw your attention to it more particularly to-day. It may be described at once as a method of permanent subcutaneous suture suitable only for recent fractures. Although many of you must have seen these cases either at the operation or subsequently when they visited us from time to time here with the object of showing us the results, it may be well if I describe briefly what was the plan adopted.

All four cases suffered from simple transverse fracture of the patella, and all were operated on within the first twelve hours after the injury, therefore within the period during which the blood effused into the joint is still fluid as a rule. The operation is performed as nearly as possible as follows: Every precaution having been taken to secure perfect asepsis, the lower fragment of the patella is steadied at either side by the left forefinger and thumb of the operator, who stands on the right side of the patient. A narrow-bladed knife is then thrust into the joint edge upwards, exactly in the middle line of the ligamentum patellæ at its attachment to the lower fragment. As this knife is withdrawn cutting upon the lower edge of the latter the skin wound is slightly enlarged to about two-thirds of an inch. Through the wound thus made a stout, handled pedicle needle is thrust into the joint behind the lower fragment, and is pushed upwards behind the upper fragment and through the quadriceps tendon in the middle line as close to the border of the bone as possible (Fig. 1).

Fig. 1.—a, the needle in its first position behind the broken fragments receiving one end of the silk b.

The upper fragment at this moment should be forced down and steadied. When the point of the needle is seen under

the skin the latter is drawn upwards, and an incision is made upon it and for two-thirds of an inch downwards to the edge of the patella, the knife entering the joint in the middle line over the needle. The eye of the needle is now threaded with stout perfectly sterilised silk or wire (b), and is withdrawn, carrying the thread of course behind both fragments. The needle, again unthreaded, is now passed through the same skin wound below and out of the upper wound, but this time in front of and close to both fragments (Fig. 2). Here it is

Fig. 2.—a, the needle in its second position in front of the broken fragments receiving the other end of the silk c.

threaded with the other end of the suture, (c) and is withdrawn. The thread now forms a loop over the upper border of the upper fragment, both ends hanging out of the lower wound, one arm of the loop passing, of course, behind and the other in front of both fragments. The upper fragment is then forced downwards by an assistant until its broken surface touches that of its fellow, against which it is rubbed by lateral and antero-posterior movements until it is felt that any blood clot or other material is dislodged, and they are both in position and grating. The operator then pulls firmly upon the suture, and ties or twists its two portions upon the lower border of the patella. The projecting ends are then cut off, and the small skin wound closes over the knot. Neither of the wounds above or below the patella requires drainage or suture; they are simply covered with an antiseptic pad; the whole joint is then enveloped in salicylic wool and evenly bandaged, and the limb is put up on a long back splint. When the wounds are made into the joint, as much blood and clot are squeezed out through them as possible. In Case III I thus evacuated eight or ten ounces with ease. It is important that the edge of the knife should cut upon the upper and lower edges of the patella in making the two punctures, so that the suture may embrace the fragments of bone closely without any intervening fibrous tissue, and that the contact of the broken surfaces may be firm and remain firm.

In the first three cases I operated on by this method I used silver wire, and have no cause to regret it. But though the results left little or nothing to be desired, as you have seen, it occurred to me that stout silk would be quite as good, and might perhaps not be open to some of the objections raised to wire, such, for instance, as leaving a rigid knot on the front of the ligamentum patellæ.

The after-treatment consisted in keeping the patients in bed, with an ice-bag over the knee until the skin wound's

were healed, which took place in all under one dressing and without a drop of suppuration. At the end of eight or ten days the splint was removed, and the patients were allowed to move the knee a little while in bed. After the lapse of a fortnight they were allowed to sit up a little with a splint on, which was removed on returning to bed. In none of the cases was there anything to give cause for anxiety in the course of the case, and at the end of five weeks all were able to walk firmly, and no trace of the line of union in the bone could be made out.

In future cases I think I should begin passive movement even earlier and carry it out daily, gently, and methodically. Knowing now the strength of the suture and that it gives rise to no irritation in the joint I should not fear the strain put upon it, and should expect an earlier restoration of perfect function.

Let me now recall to you the condition of the patients when last examined.

CASE I.—C. W. D., aged 22, when seen the other day, nine months after operation, possessed a knee in all respects as good as its fellow. The patient could sit down upon his heels and jump up briskly, and could hop across the room swiftly on the injured limb without the slightest help. He said that lately he had done harder work in running up and down ladders and pushing barrels about than ever in his life before. Some eight or nine weeks after operation he fell off a ladder and wrenched the affected knee. This was followed by enusion into the joint, and when I then saw him I was uneasy about the result. The swelling, however, soon went down, and he commenced hard work. The line of union in the bone cannot be made out in the least, and is apparently bony. He can tell where the knot of the wire is when the skin is pressed below the patella, but is otherwise unconscious of its presence.

CASE II.—W. P., aged 36. This patient was seen two or three weeks ago, eight months after operation. The result is also excellent, though not quite so good as in the first case. The man does not appear to be quite as strong on his leg as his neighbour. But then he strikes one as a timid individual, and—having had some injury to his knee some months before fracturing his patella, an injury which we cannot define, but which he says “left a weakness behind”—it may be that we have some of the effect of the first lesion before us now. He can, however, nearly sit on his heels, and can hop a little on the affected limb. The union is apparently bony, and the point of fracture cannot be made out. The wire can be felt over the front of the patella, but gives him no inconvenience whatever. It is interesting to note that the thigh on the injured side is much smaller than its fellow. Whether this is due to atrophic changes or to the fact that he had an attack of thrombosis in the veins of the opposite limb, with much swelling, soon after the accident I cannot say.

CASE III.—D. Y., aged 72, was a hale and cheery man, who looked less than his age. We saw him last about nine weeks after operation. He then walked firmly into the room without a limp and was able to flex the knee to more than a right angle. Owing to his age, I did not like to put him to any severe test, such as hopping or stooping low. The affected knee was painless, and almost perfectly normal, except for a slight feeling of weakness, which was passing off. The wire could not be made out, and the patient was unconscious of its presence. The line of union was undiscoverable, and was to all appearances bony. This is the case in which I let out 8 or 10 ounces of blood from the knee at the time of operation. Mr. Ionides has kindly written to this patient recently to come here that we might examine him, but apparently he has changed his address, for the letter was returned. I have no doubt, however, that he will turn up soon, for he was very grateful. If any of those present hear of him indirectly or meet him I shall be much obliged if they will remind him that we are anxious to see him.

CASE IV.—P. N., aged 43.—This man is said to have been struck upon the knee-cap, but the fracture was of the ordinary simple transverse variety, with much effusion of blood into the joint. We last saw this patient here six or seven weeks after the operation, when he could walk without limping. The knee could be flexed nearly to a right angle, and was rapidly improving in that respect. It was still somewhat swollen, but was less so every day, and was growing stronger. On account of the direct injury and great effusion, I had kept him longer in bed and at rest than the earlier cases. Union was apparently bony, and there was no trace of the silk sutures employed in this case in place of wire. I have examined this patient to-day, February 8th, 1892, there is still considerable stiffness and some pain in the joint. The union appears to be bony and the patella is freely movable laterally. The silk cannot be felt. I rather suspect that the direct injury in this case has set up some tuberculous synovitis. The patient was doing hard work for some time after the operation as bricklayer's labourer, but the knee became stiff and swollen and he had to desist. He was at the end of his resources at this time and very badly fed.

With these excellent results before me I have been naturally interested to learn what has previously been done by others in the operative treatment of fractured patella. To find this out it has been necessary to undertake a wide course of reading in the literature of three or four countries, aided by such indispensable indices as the *Centralblatt f. Chirurgie*, Virchow and Hirsch's *Jahresbericht*, the *Index Medicus*, and Dr. Neale's invaluable *Digest*. But if the history of this subject ranging over many years is very extensive, it is very interesting and pleasant reading. Clustered around this simple lesion is a veritable galaxy of surgical luminaries, all concentrating their brilliant light upon it. And yet at the present moment the question which is the best routine treat-

ment of simple fracture of the patella is by no means settled. This is the first point that strikes one as remarkable in undertaking a study of the subject. The fracture itself is one of the simplest possible, and still, after many decades of experience of non-operative and operative treatment, surgeons are widely divergent in their opinions as to what ought to be done. And it is not only a question whether we ought or ought not to treat this fracture by direct operation. Even those who are in favour of treatment by suture differ most essentially as to the mode in which this should be applied; and not only so, but also as to the moment after the injury at which the operation should be undertaken. Some are in favour of immediate suture of recent fractures. Others oppose this practice, but admit that suture may be justifiable for old, badly united fractures, with great loss of power in the limb. But even among those in favour of immediate operation for recent fracture there is considerable difference of opinion as to the best operation.

Let us confine ourselves to those who belong to this class, and glance at some of the procedures which have been recommended for fresh fractures. From Severino's proposal in the sixteenth century to suture the broken fragments of the patella down to Rhea Barton's actual performance of this operation in or about 1843 was a long interval. But since this last date, operations on the broken patella have gone on increasing rapidly in number.

Malgaigne's hooks and their various modifications have appeared, then Volkmann's temporary “tendon suture” with a thread followed (Fig. 3); later on, Kocher's “peripatellar tem-

Fig. 3.—Volkmann's method before the threads are tied across front of patella.

porary suture” with wire was introduced (Fig. 4); but it was undoubtedly Sir J. Lister's experiences, published in 1877, of suture of the fragments themselves with silver wire (Fig. 5), after free opening of the joint and washing out the blood clot, which gave the greatest impulse of all to the operative treatment of this fracture. They did this in two ways; first by disclosing the true obstacles to coaptation in fresh fractures of the patella, a matter much debated before, but which could now be studied *in vivo*; secondly, by demonstrating that aseptic opening of the knee-joint is quite safe. But the experience accumulated at the hands of many surgeons aiming at the Listerian method soon showed its weak as well as its strong points. First, that it demanded great skill in

securing absolute asepsis; then, that in old fractures it was often impossible to secure coaptation of the fragments without such extensive division of the quadriceps tendon or muscle as to make the procedure very severe and liable to great risks. Von Bergmann's amplification of the operation by chipping off the tuberosity of the tibia, so as to allow the lower fragment to slip up to its fellow, hardly obviated these objections. Finally, the necessity of complete immobilisation for many weeks when the open method is adopted, has been regarded as a great drawback by many as tending to stiffness of the joint.

Fig. 4.—Kocher's method before the wires are drawn tight over pad.

All these objections to the open method have certainly some validity, and have inclined many surgeons to the belief that the great field for the Listerian procedure is among recent fractures. They have also suggested to surgeons the possibility of devising methods of securing the freshly broken fragments by operation without laying open the joint. Thus the late Mr. Marshall proposed and practised at this hospital in 1878 on two cases his method of transfixing the two frag-

Fig. 5.—Lister's open method before the wires are twisted.

Fig. 6.—Marshall's method; also Lund and Myles.

ments with steel rods (Fig. 6), and bringing them into contact by tying the ends of these rods together on either side outside the skin. This procedure was again brought forward

by Mr. Lund in 1882, and has been revived since (in 1889) by Mr. Myles, of Dublin. It has also been recently modified by Mr. Mayo Robson, who passes the pins through the tendons above and below the fragments (Fig. 7), instead of trans-

Fig. 7.—Mayo Robson's method.

Fig. 8.—Ceci's method.

versely through the bones themselves, securing them exactly as in Mr. Marshall's method.

Again Ceci, an Italian surgeon, has endeavoured to get over the objections to opening the joint by drilling the fragments subcutaneously and wiring them permanently (Fig. 8). His suture passes through the bones in a figure-of-8, and is not easy to apply with perfect coaptation.

To all these subcutaneous methods there are objections of one kind or another, although they are undoubtedly safer on the whole than the open method. In the first place they make no provision for removing the blood clot and aponeurotic fibres from between the fractured surfaces which the open method accomplishes perfectly. And if it be urged that preliminary aspiration of the joint as first recommended by Mr. Christopher Heath in this country and by Volkmann and Schede in Germany, removes this objection somewhat, there remains the difficulty of drilling and perfect coaptation of the fragments by subcutaneous manipulations. Moreover, aspiration will not remove firmly clotted blood which has been shown, in many cases treated by the open method, to be a real obstacle to complete adjustment of the fragments. To most of the subcutaneous methods, moreover, the objection may be raised that they do not permit of early movement of the knee—a matter of vital importance. And further, as most of them only aim at temporary suture of the fragments, the removal of the temporary bond of union leaves the newly formed plastic material open to the whole strain of movement, active or passive.

The method of permanent subcutaneous suture by which the four cases I have related were treated, gets over several of the objections to the other temporary methods. It was suggested to me by Kocher's procedure, which of course differs most essentially from it in aiming only at temporary fixation of the fragments, and moreover in requiring an extra daily pull upon the wires to bring the latter together, finally in leaving an open puncture communicating with the joint for some weeks. In short, Kocher's method is not subcutaneous at all. The procedure now described aims at evacuating the joint more perfectly than would be possible by aspiration, and then at bringing the fragments together by a median suture easily and rapidly applied in the direct line of strain and without any drilling. It leaves no open wound communicating with the joint, and the suture is at once buried. Finally, the suture embraces the broken fragments

tightly, and will withstand any reasonable strain necessary for passive movements at an early stage of the after-treatment. It has been shown over and over again in arthrectomies operated on by Volkmann's plan of transverse section of the patella that this bone unites rapidly and firmly by bony material when perfectly coapted, and the present cases demonstrate the same fact.

Three objections may be urged to the procedure now described. First, that the suture may give trouble in the joint, inasmuch as it lies in the axis of movement. However, we need not expect this, and, as a matter of fact, none of the four patients treated by it are conscious of the presence of the suture in the joint. Next the knot might possibly cause pain in front of the knee, but this has not been the case with any of these patients. Lastly, the joint has to be opened and transversed by a needle. But in answer to this objection it may be urged that this is no more than what is done in aspiration, which has been long recognised as a perfectly safe procedure in the hands of careful surgeons.

From the numerous efforts that have been made of late years to perfect the methods of suture of the patella, and the fact that so far none of them has come into general use, it may, I think, be safely predicted that surgeons will not rest until at last some simple plan of operation is devised which will ensure perfect coaptation of the fragments in recent fractures with little or no risk (a) as to infection of the joint, (b) as to subsequent separation of the fragments, (c) as to residual stiffness. This procedure, whatever it be, must be so simple as to require no extraordinary skill on the part of the surgeon. It must be so safe as to justify its being used at once for all recent fractures without hesitation. It must give such good results as to function as to outdo everything that has been achieved through treatment by splints.

Whether the method I have here described is a step in this direction or not time only can show. But having myself operated by the open method on other cases, and so far with successes and no failures, and having seen other methods employed by my colleagues, I am in a position to contrast several of the plans in use, and can say that, were I to fracture my own knee-pan, I should prefer to have it treated by the permanent subcutaneous suture rather than any other.

I have hesitated to refer to this procedure as a new one; it may have been employed by others without my having been able to discover the fact after careful search and inquiry. But the question is not whether it is novel but whether it is good, and if other surgeons have ever employed it I shall be greatly interested to know whether they have been as favourably impressed by it as I have in the results of these four cases.

I have just examined a fifth case in which I operated a week ago (February 2nd) by the same method. The joint is quite quiet and I have already commenced passive movement. The whole procedure only lasted four and a-half minutes.

CONTRIBUTIONS TO THE PHYSIOLOGY AND PATHOLOGY OF THE MAMMALIAN HEART.¹

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(AN ABSTRACT).

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We have sought to study the action of the mammalian heart in conditions (unexcised and intact) as nearly approaching the normal as we were able to make compatible with the employment of exact methods of research.

In our complete paper, which will shortly be published, we describe a cardiometer which we employed to measure the "contraction volume" and the "output,"² as well as the

changes in the volume of the heart other than those due to its rhythmic contractions and expansions. A description will also be given of the method of employing it, together with a statement as to the degree of the accuracy with which, according to our experience, the instrument supplies information regarding changes in the volume of the heart. We will also describe an automatic "counter," which we employed for measuring out and recording the output of the heart, as obtained by the cardiometer.

Another instrument which was found of great value in our work is our myocardiograph, which we made use of to record the contractions and expansions of any part or parts of the ventricular or auricular walls without interfering with the movements of the heart. In most cases we employed this instrument to obtain simultaneous records of the contractions of one auricle and one ventricle. We have great doubts as to the value of observations made on the heart by "button" cardiographs.

Each ventricle is sufficiently nearly spherical to permit us to deal with the mechanics of the ventricles on that basis, and, whatever the method of research employed, it is important to keep in mind the relationship of the circumferences of spheres and their cubic contents. If the circumferences of spheres be taken as the abscissæ, and the cubic contents represented as ordinates, the curve obtained is a "cubical parabola." For example, reduction by 1 inch of the circumference of a sphere of 5 inches circumference is accompanied by a reduction of the contents equal in amount to that which accompanies the lessening by $\frac{1}{4}$ inch of a sphere of 10 inches circumference, although in the one sphere the circumference is lowered $\frac{1}{5}$, and in the other $\frac{1}{10}$.

It is important, also, to keep in mind that the strain on the walls of a hollow spherical shell increases uniformly with the circumference; in other words, that the resistance to contraction of the ventricular walls becomes greater as the circumference is increased. It is well, also, to note that a change of pressure in the aorta or pulmonary artery has the same effect on the resistance to contraction offered to the left or right ventricular walls as an increase or decrease of a weight hung on a parallel-fibred voluntary muscle which is caused to contract by single induction shocks causing maximal contractions. If you increase the weight, it is not pulled up so high, and *vice versa*. An analogous result takes place in the case of the ventricles. When, from any cause, the resistance to contraction is increased, or their force of contraction, from any cause, is reduced, their walls contract less completely, and the amount of "residual" blood left in their cavity at the end of systole is increased.

We now come to the effects of the vagus nerve upon the heart. We begin with the changes in the "contraction volume," and find that, at first sight, our curves seem to show that, other things being equal, the volume of blood expelled at each systole varies in inverse ratio to the rapidity of heart beat. We find, however, that this general law does not hold good for vagus slowing (if, indeed, it be exact for slowing of any kind), which is found to be accompanied by a lowering of the "output." That, with moderate slowing, this diminution of the output may be as much as 30 or 35 per cent.

The increase in the amount of residual blood in the heart, which is produced by vagus excitation, does not necessarily indicate any weakening of the ventricular contractions.

We next analyse myocardiographic records of the action of the vagus upon the heart, and find that the auricular contractions are weakened or arrested, noting that the influence of the vagus upon the force of the auricular contractions bears no constant proportion to the vagus slowing. By fairly strong vagus excitation or by muscarin the auricles may be completely arrested, it may be, for hours. This complete arrest is, in some cases, led up to by progressive weakening, but sometimes arrest occurs immediately after fairly strong beats, or with fairly strong beats presenting themselves at times during the arrest. These latter cases may be explained by weakening of the excitations which reach the auricles from the sinus, although they are possibly due to diminished excitability of the auricles.

On coming to the effect of the vagi upon the ventricles, we find that the distension of the heart during vagus actions is due to the ventricles being more expanded, both in diastole and in systole. We point out that the increased volume of

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² "Contraction volume" is the volume of blood expelled by the heart at each contraction. "Output" is the volume of blood expelled by the heart in any given time.