RESULTS OF AN EXPERIMENTAL INQUIRY
AS TO THE
BEST METHOD OF RESTORING THE CANAL AFTER
REMOVING PORTIONS OF THE SMALL INTESTINE.

BY
E. STANMORE BISHOP, F.R.C.S.

(COMMUNICATED BY SIR SPENCER WELLS.)

Received February 5th—Read May 10th, 1887.

I DESIRE, in the first place, to express my satisfaction at being, by the courtesy of Sir Spencer Wells and your kind permission, enabled to bring my experiments and their results forward this evening, and, in the next place, to explain as far as I can the object with which these experiments have been performed and the results so far obtained.

And to clear the way I start with four propositions.

1. Union of the intestine is peculiar in this, that in no other tissue is it so imperative that absolute and perfect apposition should be obtained and maintained until organic union has taken place in every part. Anything less than this may result in a leakage, septic peritonitis, and death.

(Blood-vessels are of course excepted, but I am not aware that any serious attempt has ever been made to suture these with a view of restoring their lumen.)

2. Our ideal object in operations on the intestine is to restore the *status quo ante*, that is, to reproduce a tube of normal calibre, with no contractions at the point of suture, and free on its serous surface from any adhesion to parts around which may restrict its normal movements or act as a band under which another loop may become strangulated.

3. Nothing traceable to the surgeon himself should be left behind when the operation is finished which may render the patient liable to a second interference to obviate or remedy its effects.

4. It is necessary in order to obtain rapid and firm union that the two serous surfaces should be applied face to face, in other words, the coats must be turned inwards. A valvular, ring-like projection must thereby necessarily result, surrounding the entire lumen, and narrowing by so much and for so long as it exists the calibre of the gut.

Premising the above, it follows that the ideal suture for enteroraphy should accurately approximate and hold in position every part of the apposed surfaces of the gut, not only at the time of suture but also until firm organic union has taken place between the parts. It should not tend to contract the intestine, should not produce permanent adhesions, should leave nothing in the bowel but what may easily pass through any part of it, and, lastly, should remove as it comes away the valvular ring as soon as its purpose has been secured.

Can so much be said of any suture at present proposed or in use for this purpose?

Of sutures for the intestine there exist already thirty-four different kinds. But it is not necessary to describe them all in detail, nor should I venture to weary this Society by attempting it. Those members who care to examine them in full I venture to refer to a small paper of mine which appeared in the 'Medical Chronicle,' September,

1885. These sutures fall naturally into groups, which may either be at once set aside as useless or their respective merits and demerits compared.

Inasmuch as the first group does not attempt to comply with the primary necessity, that of approximation of serous surfaces, it will be sufficient merely to mention the names of their proposers, and pass at once to those methods which observe this law. The first group contains those proposed and described by John Bell, Reybard, Le Dran, Larrey, Ritch, Sabatier, Ramdohr, Louis, Chopart and Desault, Benjamin Bell, Amussat, Beclard, Henroz, Assaki and Duplay, Heister, Garengéot, Petit, Richter, Löffler, Palfin, and the *sutura quatuor magistrorum*.

The next group contains but two—the methods of Bau-dens and Denans. These both require the use of internal metal rings. Not only are these difficult to introduce but—and this is the chief objection to them—the rings are left behind in the interior of the intestine, and are foreign bodies which when loose will make their way towards the anus, and may at any time form the nucleus of an obstruction which will necessitate a fresh operation for its relief; moreover, if these methods are practised upon the small intestine how are these rings to pass the ileo-cæcal valve, and are they not almost certain to set up irritation, even ulceration, at that point?

Of the two remaining groups it may be said that they contain all the methods at present in use, and it is needful, therefore, to devote more attention to them. Fortunately, however, the main points of each class are the same in each modification, and the advantages and disadvantages depend so much upon these main points, that it is not necessary to take each individual method separately.

The first of these, or the third group in order, comprises the methods of Dupuytren, Vesien, Gely, Appolito, and Bouisson. All these agree in the use in various ways of a continuous thread.

The fourth group comprises the methods of Lembert, Czerny, Jobert, Briedenbach, and Gussenbauer. All these

are interrupted stitches, isolated from one another and placed vertically to the plane of the intestinal lumen.

The use of a continuous thread has certain advantages; by it the entire surfaces are firmly brought into apposition at the time of suture, and if applied with mathematical exactness the thread is capable of producing absolutely correct apposition, no point being left unguarded; but it has a capital disadvantage, which, I submit, renders it absolutely untrustworthy. All sutures tend to work their way loose into the lumen of the gut. All parts of the bowel do not throw off the suture at one and the same time. However firmly the suture may be applied, however thoroughly it may bring the apposed surfaces together at the time, it is only firm and efficient as long as every part of it is so; when, therefore, it has become loose by the natural freeing of one part, any other portion of the divided surface not yet firmly and organically united will leak and the whole aim of the suture be defeated. To put it in another way, no patient or surgeon will feel safe until the time required for the loosening of the whole thread has elapsed; until that time there will always be the possibility of sudden leakage, peritonitis, and death.

The advantages of interrupted sutures are these. They are comparatively easily and quickly used; they allow of fairly easy adaptation of one bowel-end to another, and each stitch is independent of its fellows, so that the fall of one does not tend to loosen the grip of its neighbour. But the drawbacks are serious. Placed as they all are, vertically to the plane of the intestine, they command absolutely only that line of intestinal wall within their grip; between each stitch and its fellow is a portion of wall which is free, and these spaces tend, as Travers said, "to form apertures, the diameter of which is as the distance between the stitches." The danger of such possible apertures need scarcely be pointed out. Besides, these stitches can have no influence upon the after behaviour of the valvular ring, which may hereafter act as an obstruction. It may be said that this ring will

probably flatten down in time, but I am not aware of any observations which prove this. Certainly in themselves these sutures have nothing likely to secure such a result.

Therefore the case stands thus: the continuous sutures have disadvantages where the interrupted have advantages, the interrupted drawbacks, which the continuous avoid; neither of them have any after effect upon the valvular ring, nor do I see how they can have.

If then a suture were devised, which, whilst interrupted so that each stitch were perfectly independent, should yet obtain all the advantages which a continuous has to offer, in that it accurately approximated every point of the two surfaces to be united, and permitted no space to remain unguarded until firm organic union had taken place, would it not be allowed that a distinct advance had been made towards a perfect suture for this purpose? And if, when this was done, it could be shown that the disposition of the suture resulted in that as it came away it carried with it the whole of the "valvular ring" left behind at the time of operation, surely it would be admitted that this method most thoroughly fulfils all the requirements of the ideal suture described above.

Permit me very shortly to describe its method of application.

The two divided ends of intestine being brought together so that their mesenteric borders lie in an exact plane, a fine round needle, No. 11, armed with a long double silk thread, is passed from the mucous surface of one, through the entire walls of both, to the mucous surface of the other. The needle, and with it the double thread, is drawn through until about five inches of the thread are left on the side from which it has been passed. The needle is then again passed in the reverse direction, at a distance of 2 to 3 mm. from the first puncture, and the threads drawn through until a double loop is left, having also a length of five inches. (Fig. 1.) One of the loops is cut through, the other is drawn up, and knotted with a reef-knot on the side started from. When

the knot is made the ends are cut off close. Thus one loop has been formed, uniting the two bowel walls by their serous surfaces. On the far side of the loop a long single thread is left, passing through the same opening as that passed through by the distal limb of the loop. (This thread is required later in finishing the last loop, and is useful all through the operation as a means whereby the

FIG. 1.

- A. First thread left by dividing one of the first two loops.
- B. Threads which drawn up and tied will form the first loop.
- C. First loop.
- D. Left limit of second loop.
- E. Abdominal wound.

bowel may be kept in position at the abdominal wound). On the near side of the loop is another thread attached to the needle, and also passing through the same opening as that which holds the near limb of the loop. Reversing the needle and carrying it again through the walls in the same direction as at first another loop is made, which in

its turn is knotted on the opposite side to the first knot, (Fig. 2), and by a repetition of the same acts a series of loops is formed all around the lumen of the intestine, each individual loop surrounding its own moiety of both walls, passing through the same openings as its fellows on either side, but perfectly independent of them, lying transversely to the line of union, and parallel to the plane of the

FIG. 2.

- A. Lumen of intestine.
- B. Knots of suture inside intestine.
- C. Everted mucous membrane.
- D. First thread left to unite with last to form last loop.

intestine, not so tightly tied as at once to strangulate the tissue enclosed, but certain, as it ulcerates out, to carry with it that portion of the valvular ring. The knots, and nearly the whole of the loops, are, moreover, inside the re-formed canal. (Fig. 3.)

No needle is used with a cutting edge. All the stitches

are made with a small round needle, which pierces, but does not cut the tissues.

The finest silk is used, as it is not desired that the material of which the threads are made should be absorbed, but that it should be cast off into the lumen of the canal ; on the other hand, fine catgut is used for uniting the mesentery for the opposite reason.

FIG. 3.

- A. First thread left to unite with last to form loop.
- B. Abdominal wound with bowel at level of the skin. Half the circumference is united, and the resulting valvular ridge is seen with knots of suture on both sides.

As the stitching goes on the two ends of the bowel become turned in, so that at last the suture lies entirely within the intestine, being separated from the peritoneal cavity by a space equal to the thickness of the wall of the gut.

As each loop is tied it will be seen that if, instead of cutting off only the ends of the thread engaged in making

that knot the needle is cut away entirely, one long thread will be left passing through the last opening made. When the last loop comes to be tied, this is done, and the loop is formed by tying one end of this thread to the corresponding end of the first, which, it will be remembered, was left on beginning the suture (Fig 4). The loop thus formed is drawn up, and knotted securely on the opposite side, thus closing the bowel.

FIG. 4.

- A. First thread united with last to form the last loop.
- B. Reunited intestine presenting at level of abdominal wall.
- C. Abdominal wound.

It will be seen that it is possible to finish the suture entirely in this way, leaving almost no point of the stitch in sight; but in practice it is often more satisfactory, after the last loop is tied, to introduce one Lembert suture, so as more evenly to close the final opening. This stitch is made with gut, as its use is merely temporary, and absorption of it is desired.

The results which, *a priori*, are expected from this method are the following:—The specimens will show whether or not they have been obtained. The advantages of both interrupted and continuous sutures are obtained, and their drawbacks consequently avoided. Leakage, except from the giving way of the knots, which should never happen if the silk is reliable and reef-knots used, is impossible. The serous surfaces are accurately applied to one another. Each suture affects its own moiety of tissue and no other. The sutures and knots being contained in the lumen of the intestine from the first, make their way most easily in the direction shown by Travers, B. Bell, Dupuytren, &c., to be the one always followed by intestinal sutures, namely, towards the interior.

From the same cause, *i.e.* the disposition of the threads and knots, no constantly irritating foreign body is left in contact with the peritoneum covering surrounding parts. Such bodies, even if perfectly aseptic, will develop, and tend to render permanent the results of plastic peritonitis, results such as adhesions between the sutured intestine and neighbouring coils, the wall of the abdomen, and, but far more constantly, with the omentum. Such adhesions cannot fail to be sources of future danger. Some adhesion of the omentum appears almost always to follow the infliction of a wound, but it is claimed for this stitch that, no *constant* irritation being present, such adhesion does not become firmly organised, but tends to become again loosened, and between the second and third month becomes again perfectly free, and in its normal relation to the wounded part.

No after-contraction takes place in the part sutured. The valvular ring necessarily produced in the first instance by any stitch capable of properly uniting the intestine, is by this suture again removed, and a smooth internal surface, covered by villi, is left. This process commences during the first fortnight, and is complete usually about the third month.

To prove and illustrate the foregoing statements, I beg

to submit to your notice the following macro- and microscopical specimens :

You will notice that the valvular ring, which is well marked in specimens A. and B., is less so in all the following specimens ; in C. and D. it is breaking down, and the sutures coming away, and this in exact proportion the one to the other. In E. only one suture remains, whilst in F. and H. no trace of suture or valvular ring can be found. The omental adhesion is complete in the first five specimens, yet much less strong in specimen E., whilst in specimen G. it exists only as two small threads. In specimens F. and H. it has ceased to exist altogether.

Specimen G. shows that these changes do not proceed as quickly in some cases as in others, but that they are always of the same kind.

The microscopical specimens show that connective tissue is formed between the serous surfaces, glueing them together ; that as the inner ring is cut away the superfluous tissue, like callus around bones, is absorbed, that the muscular coat, as we should expect, is not reformed, but that the ends are united by connective tissue, and that as it contracts it draws the ends of that coat very firmly together, and that the mucous membrane is so closely united that villi and even Lieberkuhn's follicles appear to exist over the internal face of the scar itself. Further details are supplied by the cards accompanying each preparation.

In conclusion, I may say that all these animals were operated upon in Owens College, Manchester, with one exception, and I beg to tender my thanks to Professors Lund, Stirling, and Dreschfeld, of that college, for their very valuable and kindly help and advice ; also to Dr. Haslam, of that college, who made all the microscopical sections, and who with Dr. Hunton, of the Ancoats Hospital, assisted me in the experiments themselves. All the animals, except the first two, were killed at definite times, being in first-rate health and condition at the time, and having given us no cause for anxiety after the fourth day. They were all treated in much the same manner, being

allowed absolutely nothing for three days, after which they were fed with Brand's Essence of Beef and water for two days : for the next week with soft milk food, and then were allowed the usual diet of dog biscuits, meat, bones, bread, &c.

The specimens referred to in this paper are now in the Museum of the Royal College of Surgeons.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' New Series, vol. ii, p. 262.)