A COMPARATIVE STUDY OF ABDOMINAL INCISIONS.*

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THE making of an abdominal incision is one of the most important steps in an abdominal operation. The development of a post-operative ventral hernia is a not unusual result of a badly planned incision, and many times this condition could be prevented by the careful selection and mode of closing the original incision.

Certain incisions appear more liable than others to be followed by ill effects. Recent statistics from the Mayo Clinic show that during a period of five years, out of a total of 29,000 abdominal operations, 536, or 2 per cent., were performed for the repair of post-operative abdominal hernia. At the Manchester Royal Infirmary during a period of two years just under 2 per cent. of abdominal operations were done for the cure of ventral hernia.

An abdominal incision when properly made should afford free access to the affected organ and should at the same time inflict the least possible amount of injury on the structures of the abdominal wall. For if the incision be so planned that muscle fibres and nerve trunks are cut haphazard, the resulting weak scar and hernial protrusion may be of such a character that the last state of the patient is worse than the first. Further, the ideal incision should be easy of execution and, if possible, free from the risk of technical error. No detail in the performance of the operation which may lessen the ultimate chance of subsequent complications should be overlooked, and for this reason the surgeon who is about to undertake an abdominal operation should have a clear idea of the anatomy of the abdominal wall. It will be advisable therefore to consider shortly the anatomical arrangement of the structures which take part in the formation of the abdominal wall.

Anatomical Considerations.

The abdominal muscles may be divided into two main groups—an anterior group consisting of the recti abdominis, and a lateral group consisting of the oblique and transverse muscles. The three muscles of the lateral group are fleshy at the back and flanks, but end anteriorly in aponeuroses. The muscle fibres are obliquely placed in different directions, but the fibres of the aponeuroses are for all practical purposes transverse. The three aponeuroses unite at the outer border of the rectus muscle and form the linea semilunaris. They then split and, proceeding mesially, form a sheath to enclose the rectus muscle. At the inner border of the rectus they join together and fuse with the aponeuroses of the opposite side to form the linea alba. The rectus muscles are loosely contained in their sheaths, being attached to them only at the lineae transversae. In the living subject the rectus muscle extends two-thirds of the distance from the umbilicus to the anterior spine of the ilium, a fact which is not always fully recognized.

The abdominal wall thus forms an elastic and contractile covering so arranged as to maintain an equable pressure and form a protection for its contents. On the tonus of the abdominal musculature depends the maintenance of the positive intra-abdominal tension which is of such great importance in retaining the organs in their normal relationship.

The nerve supply of the abdominal wall, both motor and sensory, is derived from the lower six dorsal nerves, the ilio-hypogastric and the ilio-inguinal nerves. These all enter the abdominal wall by piercing the transversalis and internal oblique muscles, and, with the exception of the ilio-inguinal, pass forward to reach the outer border of the

rectus sheath. After entering the rectus sheath each intercostal nerve divides into two divisions, a larger and a smaller. The larger branch proceeds inwards behind the muscle and enters the rectus itself when half-way across the sheath. It then breaks up into a plexiform arrangement and gives off the cutaneous branch which does not appear to cross the mid-line. The smaller division pierces the outer half of the muscle which it innervates. The nerves thus run obliquely to the long axis of the abdomen and are more liable to injury in vertical than oblique incisions. The ilio-inguinal passes along the inguinal canal and does not follow the course of the other nerves.

The blood supply of the abdominal wall is derived anteriorly from the superior and deep epigastric arteries. These vessels anastomose freely with each other and with the lateral group derived from the intercostal, lumbar, and circumflex iliac arteries. The deep epigastric artery is clinically the most important, and it ascends obliquely upwards and inwards, and runs on the posterior aspect of the rectus muscle. It should be avoided in abdominal incisions and carefully retracted to one side. Towards the mid-line there is little anastomosis with the vessels of the opposite side and the linea alba is a practically bloodless area.

The Incision.

We are now in a position to discuss the relative merits of the more common incisions and to offer some suggestions as to their suitability or otherwise.

In deciding upon the appropriate incision the surgeon will first be influenced by the position of the particular organ which has to be dealt with. Next, the incision should be so planned that it can be made where there are no nerve trunks present, or if this is not possible it should be parallel to the direction of the fibres and be so arranged as to pass between contiguous nerves. Further, it should be so constructed that the scar will not be subjected to undue strain and result in its subsequent stretching, but should leave a secure and firm cicatrix with no risk of undesirable after-effects. Maylard has emphasized the importance of making the incision through that part of the abdominal wall where there is aponeurotic tissue, for satisfactory healing of aponeurosis is the surest preventive against subsequent hernia.

The necessity of the primary union of incisions and the avoidance of sepsis hardly needs emphasizing, for infection both delays healing and leads to weakness of the scar and is the most common cause of post-operative hernia.

Historical Note.

The practice of modern abdominal surgery owes its origin largely to the work of the earlier gynaecologists who operated for tumours and obscure conditions of the female pelvis. It therefore followed that the lower abdomen was first attacked and the mid-line incision was the usual means of approach.

The first deliberate operation for ovariectomy was performed by Ephraim McDowell in 1809 upon a woman aged 47. Ovariectomy had no place in surgical procedure before that time, and McDowell placed it on a permanent basis. It was later firmly established as a recognized operation in England through the labours of Charles Clay of Manchester (who advocated the long incision from the sternum to the pubes in 1842) and Sir Spencer Wells of London. Since that time and the introduction of general anaesthetics in 1842 the history of abdominal surgery shows a continuous story of progress, as can be seen from the present-day treatment of diseases of the appendix, gall bladder, stomach, and intestines.

The Median Incision.

Incisions through the mid-line have been and still are largely used for pelvic operations. The advantages of this incision are the absence of vessels and nerves in this situation, the avoidance of injury to the rectus muscles, and the simplicity of execution, whilst it gives ready access to both sides of the pelvis. If, however, patients are examined

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some time after operation it is not uncommon to find that in a considerable number of cases stretching of the tissues and the formation of a post-operative hernia have occurred. A low median incision is the commonest site of ventral hernia not preceded by infection.

The general direction of the aponeurotic fibres in this situation is transverse, and every increase in intra-abdominal pressure and every strong contraction of the lateral muscles tends to draw the edges of the incision apart, leading to a liability to ventral hernia. The Mayo operation, which is so successful in the radical cure of umbilical hernia, is based on the principle that the lateral muscles are inserted into the linea alba and when they contract tend to pull it apart. If, however, the opening is closed transversely the pull of the muscle draws the edges of the opening together, so helping to close it. I think most surgeons will agree that these are sufficient reasons for departing from the use of the mid-line incision.

The Transverse Incision.

The transverse incision across the lower part of the abdomen is also employed in gynaecological work. It is, I believe, popular abroad and found to be generally satisfactory, though I have never seen it used here.

In Pfannenstiel's modification the rectus sheath is opened transversely, and the rectus muscles being separated in the mid-line can then be readily retracted laterally. The advantages of this incision are the strength of the resulting scar and that no nerves or muscles are damaged. Its main disadvantages are the length of time required both to make and close the incision, and that without division of the muscles and ligation of the deep epigastric arteries it gives only limited space. It is therefore only applicable in certain cases, and of little use should a general exploration be required. A transverse incision has also been advocated by Professor Lanz of Amsterdam as giving good access and inflicting little damage in appendix operations, whilst Rutherford Morison employs a transverse incision for operations on the gall bladder.

The Closure of Abdominal Wounds.

It will be convenient at this point to say a few words on the different modes of closing abdominal incisions. The earliest method, that of the so-called through-and-through suture, penetrated all structures from the skin to the peritoneum. This, however, led to faulty approximation of the different layers, and the sutures being under considerable tension were apt to cut through or cause atrophy of the tissues underneath. The resulting scar was both wide and weak, and being in a single line from the surface to the peritoneum was liable to lead to an incisional hernia. The suturing in layers was a vast improvement on this method and gave good approximation, but left a linear scar continuous throughout all the layers of the abdominal wall. This can be obviated by dividing the tissues in different vertical planes so that the scars are covered by a sound layer above and so ensure increased strength. Still later came the McBurney muscle-splitting incision, where the tissues are divided in the direction of their fibres and the lines of division and union cross each other; it is anatomically correct. Finally, we have the incision which slides to one side the rectus muscle, which is replaced uninjured after the operation, as in the Battle and the paramedian incisions; this modification possesses many undoubted advantages.

Appendix Incisions.

The first deliberate operation for suppurative appendicitis was performed in 1848 by Hancock. He made a four-inch incision extending from above the anterior superior spine downwards and inwards along Poupart's ligament. The earlier operators divided all the layers of the abdominal wall in one and the same direction. The muscle-splitting incision of McBurney was described in 1894, and Battle in 1895 gave us the incision through the right rectus sheath with displacement of the muscle inwards which has become the rival of the McBurney incision. With regard to the merits of

these two incisions, the McBurney route lies more directly over the site of the appendix, but only gives a limited exposure, and often cannot be enlarged sufficiently without cutting across muscle fibres and nerves. Battle's incision gives better access, and sufficient space can usually be obtained without injury to nerves, whilst it is less destructive.

As to the relative frequency of post-operative ventral hernia when drainage is employed, the chances of this complication appear to be greater in the McBurney incision, and I have met with a number of such cases. I seldom employ the muscle-splitting incision except when an abscess is localized under this point, and though I have used the Battle incision on three hundred occasions for acute appendicitis I have only known one case develop a post-operative hernia.

A further complication of the McBurney incision is the occurrence of a right inguinal hernia after the operation. This probably depends on some injury to the nerves supplying the lower fibres of the internal oblique and transversalis muscles, leading to atrophy of the fibres at the internal abdominal ring. Three cases of this nature have come under my notice, but I have never seen the complication follow the Battle incision; in that incision the nerves are easily seen and so can be avoided.

Gall Bladder Incisions.

The first successful operation on the gall bladder in England was performed by Lawson Tait in 1879, and to Tait and Mayo-Robson undoubtedly belongs the credit of having popularized the operation with the profession.

Mayo-Robson employed an incision which extended vertically downward through the right rectus muscle, near its outer margin, with an upward and inward prolongation at the upper end, dividing the muscle fibres. This incision is not to be recommended as it both disregards nerve trunks and cuts muscle fibres. Bevan's incision, which is a modification of the above, is equally harmful and causes serious damage to the parts. Kocher used an oblique incision about half an inch below and parallel to the costal margin, the centre lying a little to the outer margin of the rectus muscle. The nerves are retracted out of the way, and there is little fear of a hernia developing later. This route, however, only gives a poor exposure in many cases, though by carrying it outwards and dividing the seventh nerve more room can be obtained.

At the present time two incisions are popular for operations on the biliary tract. One is a vertical muscle-splitting incision passing through the outer third of the rectus muscle, an incision which gives excellent access, affords satisfactory drainage, but disregards the presence of the nerve trunks in this situation. Then there is the paramedian rectus sheath incision with outward retraction of the muscle. This route usually gives ample exposure and only rarely requires enlargement by division of the muscle. It preserves the nerve trunks intact and drainage may be obtained by a separate stab incision.

Exploratory Incisions.

The operation of exploratory laparotomy is largely a recent development of surgery, and abdominal operations tend to become more and more of an exploratory nature. Surgeons now usually employ one of two incisions for this purpose—either the rectus splitting incision or the rectus slide incision—and an endeavour has been made to consider their relative merits. The fact that each type of incision has its special advantages and its own advocates is sufficient reason for further investigation.

To form an idea of the results obtained after the use of these incisions Professor Stopford has investigated with me a number of cases after intervals of a few months or a few years had elapsed following operation. We first examined the results of the incision passing through the outer third of the rectus muscle, splitting the fibres, and where two or often more nerves had been divided. This incision is easily and rapidly made and gives good access to most of the abdominal viscera. We found there was a very definite sensory loss, as shown by anaesthesia and analgesia in the strip of skin between the scar and the

linea alba. After about fifteen months, however, the sensory loss becomes negligible, as far as ordinary testing can determine, probably owing to regeneration of nerve fibres.

In all these cases there was a marked loss of function of that part of the rectus muscle lying between the point where the fibres were split and the mid-line. This may be fairly extensive or confined to one segment of the muscle, depending on how many nerves have been divided. It is present from the outset and persists for a considerable period. In a few cases there was a slight bulge on coughing, but for the most part the loss of muscle function could only be detected when the patient raised the head and shoulders from the couch. The functional results from the patient's point of view were excellent, and after secure suture and healing by first intention no disability was apparent from the abdominal scar. As a typical example may be quoted the case of a brewer's drayman who, nine months after such an operation, was lifting barrels of beer daily without difficulty or discomfort. It appears that after careful suture of the aponeurosis the risk of hernia is very slight in the absence of sepsis and drainage.

We next followed up the results obtained by the paramedian or rectus slide incision with outward displacement of the muscle and its nerves. In these cases, for some reason not readily explained, the sensory loss is insignificant from the start. We found that in this group the rectus muscle on the side of the scar functions normally throughout, and there is no weakness discoverable after this operation.

Our inquiries show that in the absence of infection the functional result is so good that no special advantage attaches to either incision, but for accessibility the muscle-splitting incision has certain points in its favour. In the presence of infection, however, we have seen a number of post-operative herniae after the muscle-splitting incision. Infection interferes with the healing of the aponeurosis, which has but a poor blood supply, and this is further complicated by the sacrifice of a segment of muscle. With the rectus slide incision the muscle itself is uninjured and falls back to its natural position, forming an additional barrier against subsequent weakness. Further, when the wound heals without complication it is probable that the regeneration of nerve fibres occurs normally and the muscle function is quickly restored. Should infection be incurred this process may fail, owing to the barrier of fibrous tissue, through which the nerve fibres cannot penetrate, causing atrophy of the muscle and thus allowing a hernia to develop.

We have also occasionally seen patients who complain of painful areas in the scar after division of nerves, probably owing to involvement of the severed nerve fibres in fibrous tissue. Most of us must have met with the somewhat analogous condition where the ilio-inguinal, a highly sensitive nerve, has been damaged in hernia operations, leaving the patient with a painful and tender scar. Such unpleasant sequelae are fortunately seldom observed, but none the less they are too frequent, and it is important that we should take all possible precautions to avoid their occurrence.

In urgent operations on the upper abdomen the quickest and easiest approach is by a muscle-splitting incision passing through the inner third of the rectus muscle. This affords good access in cases of perforated gastric or duodenal ulcer and in acute cholecystitis, and avoids injury to the nerve trunks at the lateral border of the rectus. I recently published¹ a follow-up of 41 cases of perforated gastric and duodenal ulcer approached by this route, and when seen subsequently all possessed a satisfactory abdominal wall.

I have confined my remarks to those abdominal incisions which are in most general use. It is only by a careful study of our results and a more accurate follow-up of cases that reliable conclusions can be obtained, and any discussion of our methods on these lines with a view to their improvement must surely be of value.

REFERENCE.

¹ BRITISH MEDICAL JOURNAL, 1922, vol. i, p. 556.

THE ABDOMINAL INCISION IN PELVIC SURGERY.*

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My personal experience of gynaecological surgery dates from the time when all abdominal incisions were made in the middle line and were closed with through-and-through silkworm-gut sutures. Incisional hernia must have been fairly common in those days, as it was usual for every patient whose abdomen had been opened to wear a belt for the rest of her life. Then we began suture in layers, first with silk, and later with catgut. Gradually the use of the belt was found to be unnecessary, and was dropped except in special cases.

After suturing in layers had come into use, I omitted silkworm-gut stitches altogether for a considerable period, uniting the peritoneum, fascia, and skin separately, but putting no stitches through the muscle. The results were very good; but in a few cases serum oozed from the wound, wetted the dressing, and kept the skin moist and sodden for a few days. This was apt to permit superficial infection, which delayed and impaired perfect healing of the skin edges. I therefore sought a means of applying pressure sufficient to keep the wounds dry, and found that this could be done by inserting five or six silkworm-gut sutures through the skin, fat, and fascia after uniting the peritoneum. The silkworm-gut sutures are left untied until the fascia and the skin have been stitched with catgut. A roll of gauze about an inch in diameter is then laid over the sutured wound, and the silkworm sutures are tied over it, compressing gauze, skin, fat, and fascia. This anchored dressing gives moderate uniform pressure along the course of the incision. It is left untouched for a fortnight, when it is removed to reveal a firmly healed linear scar. There is no moisture of the wound, no cutting of the skin and no stitch abscess. There is no dressing of the wound, no taking out of clips, and no need to use little rubber tubes to cover the silkworm sutures. The method must be distinguished from that in which sutures are tied first over the skin and then again over the gauze, giving a form of anchored dressing that has no great advantage over a loose one. I have used my own method in every case during some fifteen years. It has spared me worry and lessened the work of my nurses, while it has saved my patients much discomfort if nothing worse.

The mid-line incision sutured in layers leaves the abdominal wall as good as it was before the operation. But many of the women treated in a gynaecological ward have, before operation, very defective and inefficient abdominal walls. In most parous women there is considerable separation of the recti, and in a large proportion of these the injury is considerable and even extreme. In other cases the trouble is due to stretching by large tumours.

While this parietal defect would not alone justify surgical interference, it seems a pity, if the abdomen has to be opened for some other purpose, to close it again without taking steps to secure for the patient a better abdominal wall than that she possessed before her operation. With this object I have long made it my rule to open the sheaths of the rectus muscles on both sides throughout the whole length of the incision. When this has been done the inner edges of the recti come together and lie in direct contact as the wound is closed, and this without any injury to their nerves or to their blood supply. The union secured is muscle to muscle, and the so-called linea alba is done away with. This end is gained with very little trouble. If the primary incision through the fascia opens one muscle sheath, then the fascia must be dissected up until the other muscle is freely exposed. If the primary incision goes between the recti and exposes neither of them, then the fascia must be lifted on both sides until both muscles are bared freely throughout the length of the incision.

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