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TRANSVERSE INCISION OF THE ABDOMEN— THE LAPAROTOMY WOUND OF CHOICE

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INTRODUCTION

SINCE modern surgery was first made possible through the brilliant contributions of Joseph Lister and his recognition of the fundamental importance of the discoveries of Pasteur, the abdomen has been opened for purposes of exploration and operation in the great majority of cases, and by most surgeons by means of a vertical incision. At first such openings were made in the mid-line—*linea alba*—and to a considerable extent such incisions are still employed, more especially below the umbilicus for operations upon the pelvic organs. For many years, however, it has been recognized that firm healing of this aponeurotic tissue is necessarily slow, that such a wound is subjected to very considerable lateral pull* and that consequently a prolonged post-operative period of bed rest is required. It has, moreover, long been recognized that in too large a proportion of cases abdominal wall weakness or even frank hernia has ensued. Even more important is, I believe, the pain and interference with function which arise from adhesion of abdominal viscera to the deep surface of such a wound.

The major disadvantage of the vertical incision—no matter how fashioned—is that the aponeurotic structures are cut across the direction of their strong fibres—that is at right

angles to the line of greatest strain. The lesser disadvantage is that there is great risk in those incisions which either split or displace the rectus muscle that three or more intercostal nerves may be damaged or destroyed.

The main advantage of the vertical incision is that, whatever method is employed, the incision is easily and quickly made and that there is relatively little bleeding, since the incision lies parallel to the greater part of the blood supply. Such an incision is, moreover, easily increased in length either upward or downward towards diaphragm or pelvis, as the exigencies of the case may demand.

In all cases, therefore, in which the diagnosis of an acute abdominal crisis demanding surgical interference is made, but in which it is not possible to establish an exact pre-operative diagnosis as to the site of the viscus primarily involved, the employment of a vertical incision, made to one or other side of the umbilicus, will suffice to establish the direction in which the incision must be enlarged in order to obtain direct access to the organ. Under these conditions a vertical incision is, therefore, recommended.

In this contribution it is not my intention to present an anatomical study nor a statistical analysis of cases but rather to indicate certain technical features regarding the fashioning of a transverse incision which has been eminently successful in my hands.

The author has employed transverse incisions for opening the abdomen in an increasingly large proportion of cases since 1916. At that time, while working at No. 22 Casualty Clearing Station with the British Army in France, there passed through my hands a large number of gunshot wounds of the abdomen. Although I was not familiar with the fact that transverse incisions had been previously used or recom-

* Sloan¹ carried out experimental work whereby, by means of spring balances attached to mouse-toothed forceps, he was able to gradually measure the force required to hold the edges of an incision together. He found, *inter alia*, that the longer the vertical incision the more force per inch of incision is required to bring the edges together. "The force required increased in proportion to the square of the length of the incision. If the incision is lengthened to five inches it will require about 45 pounds pull on each side to hold the edges of the incision together." He further noted that in a series of 20 cases in which an L-shaped incision was employed one side of which was vertical and the other transverse, the lateral tension was in every case thirty times as great as the vertical.

mended (Sprenzel,² Bakes,³ Moschcowitz⁴) it seemed in a certain number of cases to be advisable to join entrance and exit wounds in as direct a fashion as possible. The employment of such openings in these cases, I felt, made it more simple to identify all wounded tissues with less handling of the abdominal viscera. I was surprised, at first, to find in those cases in which such incisions were transverse—across the abdomen—that the patients were, in the first place, more comfortable following operation than were those in whom the traditional vertical incision had been employed but, also, that in the presence of suppuration, as was usual under these conditions, healing seemed to progress more favourably.

During the seven year period commencing in the autumn of 1918 the author was in charge of the Surgical Service at Ste. Anne's Military Hospital. During this time all soldiers in Canadian Military District No. 4 who believed that they were suffering from disabilities which might be ameliorated by surgical interference came under his care. During this time several hundred patients were admitted suffering from either post-operative abdominal hernias or pain which appeared to be due in some way to the presence of an abdominal scar. Since the original operations in these cases had been carried out by many different surgeons, some of them the most outstanding figures in the profession (Canadian, British, American), and since the disabilities suffered seemed so important and the difficulties presented in repair were in many cases insurmountable, I was impressed with the disadvantages of vertical abdominal incisions.

AUTHOR'S APPECTECTOMY INCISION

I have already described on several occasions^{5, 6, 7} the incision employed in my clinic for removal of the appendix vermiformis. The essential features of this incision are that after the external oblique muscle and aponeurosis are conserved by separate division and retraction, the anterior sheath of the rectus—that is to say the aponeurosis of the internal oblique—is split transversely in the direction of its strong fibres. The rectus muscle is then displaced along with the 11th intercostal nerve and its accompanying vessels, toward the mid-line and the posterior sheath of the rectus, namely the aponeurosis of the transversalis muscle, is split transversely in a similar fashion and the peritoneum opened at the same time. Since this incision commences

1.5 to 2.5 cm. below the umbilicus, its outer border if continued laterally will pass above the iliac crest so that by a separation of the fibres of the internal oblique muscle and the transversalis a sufficiently long incision can be obtained, which permits the hand to be introduced into the abdomen and which, *inter alia*, permits direct exposure of the retrocaecal tissues. Actually this incision may be enlarged laterally without the risk of damage to essential structures as far as the quadratus lumborum muscle.

In the contributions referred to, the fact that in the event of diseased organs within the pelvis requiring surgical intervention the incision may be carried across the mid-line and the right and if need be the left rectus muscles incised transversely is made clear. In this way adequate exposure for any unexpected lesion in the pelvic organs to be dealt with is obtained.

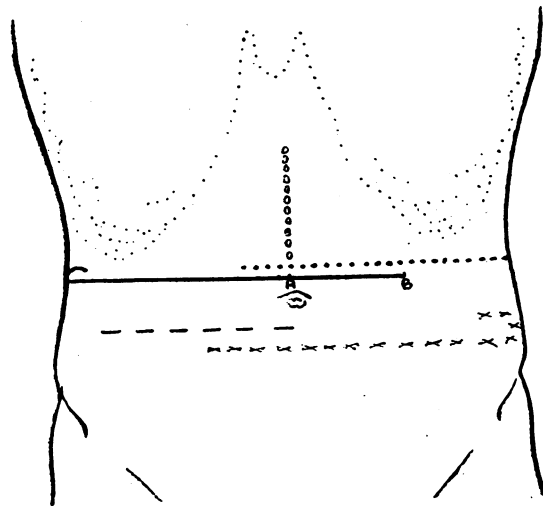


Fig. 1.—Diagram illustrating the abdominal wall to show site of recommended incisions.

— Skin incision for cholecystectomy and exploration of bile passages. Resection of hepatic flexure A. For gastrostomy or gastroenterostomy B.

- - - Skin incision for appendectomy and exploration of pelvis and terminal ileum.

..... Skin incision for splenectomy. Resection of splenic flexure.

x x x x Skin incision for resection of descending colon, abdomino-perineal resection. (Similar incision on opposite side for operations within pelvis may be used.)

TECHNIQUE OF AUTHOR'S LAPAROTOMY INCISION

The accompanying diagram (Fig. 1) illustrates the site at which incisions for operations upon the various structures within the abdomen are ordinarily placed. In order to make the diagram possible, the incision represented by xxx has been placed somewhat lower on the abdomen than such incision is, in fact, made. I believe it is of the utmost importance in fashioning the incisions that, whether above or below the umbilicus, the incision should reach

to, or cross, the mid-line within from 1.5 to 2.5 cm. of this structure. If this be done above the umbilicus, the 9th intercostal nerve can be easily found lying on the anterior surface of the posterior sheath of the rectus running obliquely downward and inward; below the umbilicus, the 11th nerve is similarly encountered. Although it is probably not of any great importance whether one nerve be damaged, or not, it is usually possible to protect the nerve, 9th or 11th as the case may be, during the course of operation.

In addition to the incisions as indicated for exposure of (1) right upper quadrant and epigastrium—the gall-bladder, biliary passages, hepatic flexure, and for operations upon the stomach; (2) right lower quadrant—for operations upon the appendix, pelvic organs and terminal ileum; (3) left upper quadrant—for splenectomy or resection of the splenic flexure; and (4) left lower quadrant—for resection of the descending colon or abdomino-perineal resection of the rectum, the line of incision indicated by 0000, which is in the mid-line and which runs at right angles from the transverse incision above the umbilicus, is added willingly in all cases in which unusual difficulties are encountered in the operation indicated above and frequently in the case of subtotal resections of the stomach for carcinoma. This mid-line incision may be carried out either subcutaneously through the linea alba or all the tissues of the abdominal wall in the mid-line may be sectioned. It is needless to point out that a similar incision may, if required, be made downward toward the bladder.

RIGHT UPPER QUADRANT

If the typical incision for cholecystectomy and exploration of the hepatic ducts be described it would seem that the application of the principles indicated, to the other incisions should be clear without unnecessary repetition.

It is my custom in operating upon the gall-bladder to carry the skin incision from slightly to the left of the mid-line to approximately the tip of the 12th rib, on the right side. As indicated above, this incision is usually 1.5 to 2 cm. above the upper border of the umbilicus. At this point the middle semilunar line is above the line of incision. The incision is carried through the skin and subcutaneous fascia down to the anterior sheath of the rectus and the external oblique muscle and aponeurosis.

Following the application of towels to the wound edges, the skin and subcutaneous tissue are retracted gently, and the external oblique aponeurosis and muscle is divided in the direction of its fibres up to the attachment of the muscle to the rib border. As a rule, 1 or 2 cm. of the lower border of the muscle is cut away from the rib border. Since at this point the nerves are deeply placed no damage to them is likely to occur.

Commencing, then, at the mid-line the anterior sheath of the rectus is divided in the line of its fibres, namely, transversely at the same level as the original skin incision. By means of careful dissection the edges of the cut aponeurosis are separated for a distance of 0.5 to 1 cm. from the muscle. The thinnish fascia overlying the internal oblique is divided transversely into the loin. By means of curved blunt-pointed scissors the rectus muscle is displaced at its lateral border from its posterior sheath. Although the rectus muscle is intimately, though not very strongly, attached to its anterior sheath, except at the semilunar lines where the attachment is firm, the muscle is not attached to its posterior sheath. It is consequently easy to insert two fingers behind the loosened muscle and so separate the belly of the muscle widely from its posterior sheath. The 9th intercostal nerve is then brought into view with its accompanying vessels. These structures together with the rectus muscle are then displaced, employing a medium-sized Koehler retractor for the purpose, toward the mid-line. The posterior sheath of the rectus is then incised in the direction of its fibres together with the peritoneum from close to the mid-line outward to its lateral edge. From this point the internal oblique and the transversalis muscles with the subjacent peritoneum are split with the fingers into the loin.

A medium-sized retractor is placed in the wound and moderate traction toward the mid-line and upward is accomplished. Gentle traction with a small retractor downward towards the patient's feet opens the wound sufficiently for exploration, both visually and manually, of the distal two-thirds of the stomach, liver, duodenum, gall-bladder, bile ducts and transverse colon including the hepatic flexure. If spinal anaesthesia is employed little or no force need be employed upon the retractors, nor do the abdominal viscera tend to protrude; consequently, at first at least, there is no necessity for

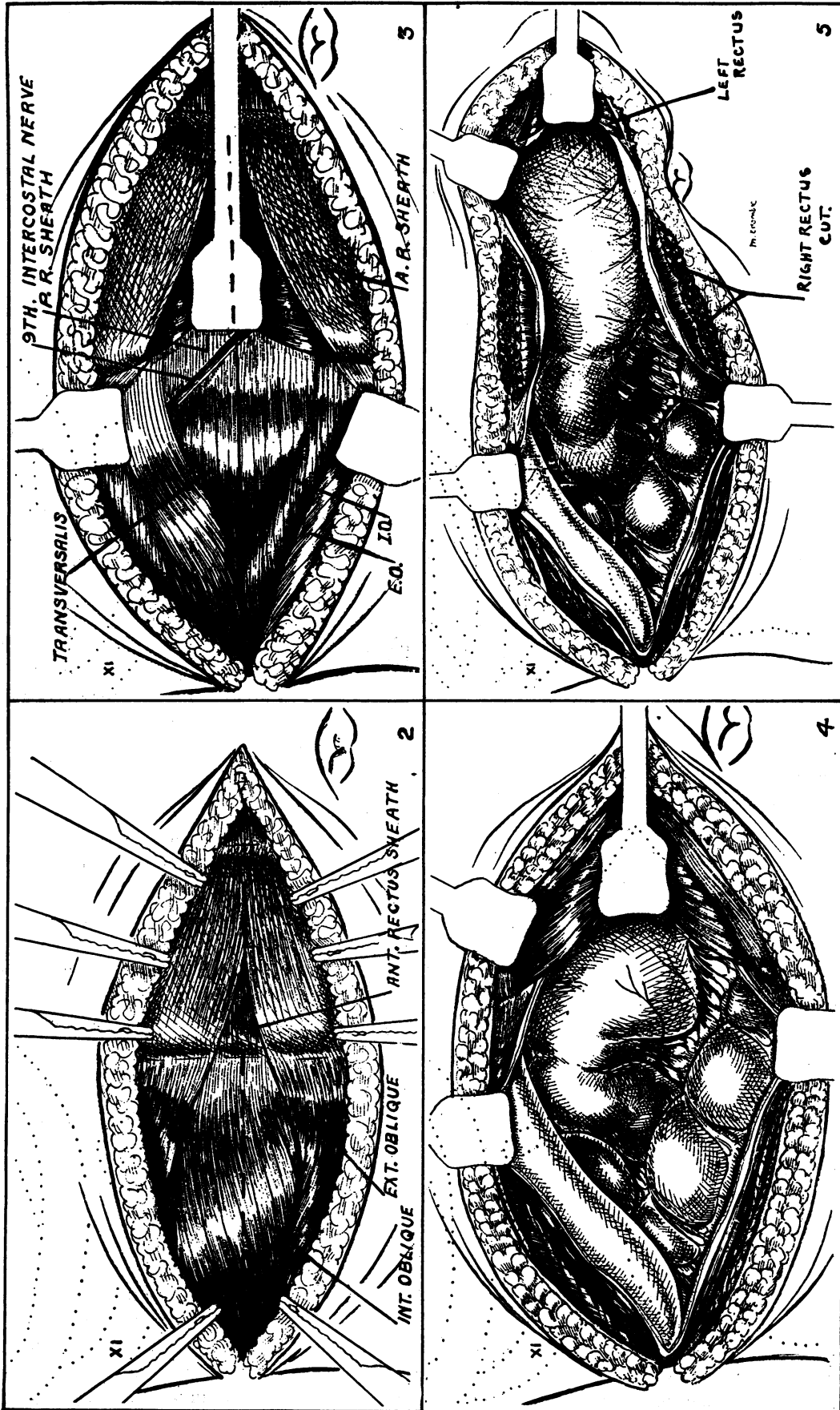


Fig. 2.—Transverse incision above the umbilicus. External oblique split and retracted incision of anterior sheath of rectus and internal oblique indicated by dotted line. Fig. 3.—Anterior sheath and internal oblique muscle divided. The rectus muscle and 9th intercostal nerve retracted toward mid-line. Line of incision through posterior sheath and transversalis indicated. Fig. 4.—Abdomen opened through transverse incision without division of rectus. Note extension of incision into loin. Fig. 5.—Abdomen opened following division of right rectus muscle. Left rectus displaced towards the left.

the introduction of any considerable amount of gauze packing.

Through an incision fashioned in this way, and which it will be noted has followed almost entirely the natural cleavage lines and which has not up to this point damaged any nerve, it is possible, in addition to carrying out adequate and easy examination of the organs mentioned above, to pass the hand into the pelvis, to examine the whole of the large bowel by palpation and, by the employment of traction in the lower lateral corner of the wound, to uncover the cæcum and make possible the removal of the appendix. Should the circumstances of the case demand examination of the small bowel, this is readily accomplished by turning up the transverse colon and omentum.

In the majority of cases in which cholecystectomy is required the abdominal wall is sufficiently lax to make it easy to obtain, through such an incision, adequate exposure of the gall-bladder and cystic, hepatic and common ducts, and to perform the operation quickly and easily. In all cases, however, in which either as the result of pre-operative indications or information obtained at operation it is deemed advisable, or necessary, to open and so explore the common or hepatic ducts I have made it a practice to enlarge the incision to the left so that absolutely no encroachment of the wound edges may interfere with easy dissection under careful exposure. When, therefore, as in operations for exploration of the biliary ducts or gastric resection, more adequate exposure than is obtained by the muscle-splitting incision just described is deemed necessary, the procedure about to be described is added.

With two fingers of the operator's left hand behind the rectus muscle, the abdominal viscera being protected in the meantime by a spread out gauze sponge placed over them, and a heavy pair of scissors employed, the right rectus muscle is snipped across its whole width, pressure from behind being exerted by means of the fingers of the left hand. If the incision is carried out in this way the vessels which are divided can usually be seen prior to sectioning and, in any event, can be clamped without appreciable blood loss or soiling.

The incision thus reaches the mid-line which is crossed by division of the linea alba and the falciform ligament in which one or two bleeding vessels from each end must be ligated. The anterior and posterior sheaths of the left rectus

are then divided transversely from one-third to their whole width. In the great majority of instances retraction then of the left rectus laterally is possible without any considerable force being employed, to obtain an opening which permits any type of operation on the biliary tract or stomach to be performed. It should again be pointed out, however, that there is no objection whatever to extending the incision completely across the left abdomen into the loin (12th rib). Furthermore, in the individual case in which, as for instance in the resection of the stomach for carcinoma, clear exposure of the cardiac orifice must be obtained, and in the occasional case in which the costal angle is narrow I have no hesitation in extending the incision vertically upward in the mid-line, or through the left rectus muscle as far as may be required. This occasional extension of the incision is indicated on the diagram by little 0000's. As indicated elsewhere this extension may be subcutaneous if no great length of incision seems indicated or all layers of the abdominal wall may be cut. If the patient's body is then slightly hyperextended in the lower thoracic region either by means of a bar or by "breaking" the table, the wound opens up in a manner comparable to opening a book so that little or no retraction of the wound edges is required.

LEFT UPPER QUADRANT

For purposes of splenectomy or resection of the splenic flexure an incision similar to that which has been described for the right side is carried out. I feel convinced that any surgeon who has attempted either of these sometimes difficult operations by means of the two methods of approach, *i.e.*, vertical or transverse, will be unwilling to again use the vertical incision.

LEFT LOWER QUADRANT

For the abdominal part of the operation of abdomino-perineal resection of the rectum, an incision similar to that already described on the left side of the abdomen below the umbilicus, with division of the left rectus muscle and, if deemed necessary, the right, renders I believe, this somewhat time-consuming and often difficult operation as easy of accomplishment as is possible. It must, however, be pointed out again in this connection that the incision must be close to the umbilicus so that it may be extended laterally (on the left side) into the loin approximately to the quadratus lumborum muscle. For

resection, also, of the descending colon and sigmoid loop whether by the Paul-Mikulitz procedure or by anastomosis, this operation gives as adequate exposure as may be obtained.

When the recommended incision is employed for abdomino-perineal (Miles) resection of the rectum a permanent colostomy is established through a separate elliptical opening above and approximately 5 to 7 cm. to the left of the umbilicus.

If a transverse incision has been employed the simple expedient of "jack-knifing" the patient so that the shoulders and thighs are raised about 15 degrees makes it possible to close the abdomen without any tension whatever, since the upper and lower leaves of the incision can easily be made to overlap one another.

Since the transverse incision may be closed without tension and since it is subjected to but little post-operative strain there is no necessity for the employment of heavy grades of catgut. I have made it a practice to employ continuous double No. 0 chromic gut for the posterior sheath and peritoneum and single continuous No. 0 chromic for the anterior sheath and for the external oblique. No. 00 or 000 plain catgut is used for the subcutaneous tissues.

DISCUSSION

Chief among the objections on the part of both patient and surgeon to exploration of, and the performance of operations upon, the abdominal viscera are risk to life (*a*) from hæmorrhage; (*b*) from infection; (*c*) from shock; (*d*) from post-operative pneumonia; (*e*) from pulmonary embolism.

In so far as *a*, *b* and *c* are concerned, risks to life as a result of abdominal operations, due to hæmorrhage, soiling and shock, are, in the main, determined by the ease with which the organs subject to operative interference are made accessible in order that the surgery required may be rendered as simple as possible. If the transverse incision be properly fashioned it, in our opinion, makes it as easy to expose and so operate upon the individual structures within the abdomen as when any vertical incision is employed. Since forceful retraction of the wound edges is not required, less trauma is inflicted upon the structures of the abdominal wall; necrosis and infection of the wound is, therefore, less likely to occur.

(*d*) Observation, I believe, of but a small number of cases suffices to convince one that

the patient whose gall-bladder and bile ducts, stomach or spleen have been operated upon by the employment of the transverse incision suffers very considerably less pain, post-operatively, than the victim of a vertical incision.

Specifically with regard to the matter under discussion, it is possible to induce patients who have been sectioned transversely to indulge in deep breathing exercises more willingly than those cut open vertically. On the other hand, they are able to cough with relatively little pain and, in consequence, do, in fact, cough, and so tend to clear the smaller and larger bronchi of mucus and muco-purulent plugs. The relative infrequency of incidence of massive atelectasis and pneumonitis in cases in which the transverse incision is used is the result (Jones and McClure⁸).

(*e*) It is not my intention in this contribution to discuss the problem of thrombo-phlebitis or phlebo-thrombosis and consequent pulmonary embolus in extenso; there is, however, I believe no difference of opinion as to the importance of early assumption of activity, especially in so far as this refers to abdominal wall and lower extremity movements, in the prevention of massive emboli. There is, I believe, also reason for believing that, within limits, the extent to which the number of days of bed rest may be cut is of importance in this direction. Observation of but a few cases suffices to prove that patients are more willing and able to carry out suitable exercises in bed, and are able and willing to get out of bed at an earlier date, when the transverse incision is used than with any of the usual vertical incisions.

If tight dressings have, as many surgeons believe, a bearing upon the incidence of thrombosis and embolism the fact that wound support from tight dressings is not required when the transverse incision is used may well be of importance in this regard.

In addition to immediate or early post-operative risk to life in consequence of laparotomy as outlined in previous paragraphs, further objections to operation—more especially upon the patient's part, are those due to: (1) post-operative pain; (2) length of time and consequent expense of hospitalization.

Even a limited experience with the post-operative course of patients subjected to transverse laparotomy will convince the surgeon who has not previously used this method of approach that patients are much less uncomfortable. The

fact that post-operative pain due to normal respiration, and more especially to coughing or vomiting, is due to an attempt on the part of the rib borders to tear the abdominal wound apart in the case of a vertical incision, acts in precisely the opposite manner when a transverse incision is used.

Finally, both the patient and surgeon, but more especially the former, consider certain late untoward effects of injury to the abdominal wall to be contraindications to laparotomy. These are: (1) post-operative hernia; (2) pain in the scar; (3) fixation of abdominal viscera.

As indicated in my introduction, it is not my intention to make this contribution a statistical analysis. In order, however, that my experiences may be placed upon record I wish to simply state that post-operative hernia following laparotomy by means of the transverse incision is of much less frequent occurrence than when any vertical incision is used.

The second and third items indicated in this section, namely pain in the scar and pain due to fixation of abdominal viscera, are of so great importance, I believe, that no more than simply passing reference can be made to them in this contribution. Sloan¹ and Bartlett and Bartlett⁹ have drawn attention to a fact which the author believes to be of the utmost importance, namely as Sloan says, "that the high incidence of post-operative adhesions on the inner side of the scar is of more consequence than the danger of hernia". Although it is unusual to see a vertical incision, or oblique, two or more years following operation in which the scar is not from 0.8 to 2.0 cm. in width, it is rare that the scar following the transverse incision shows any evidence whatever of having stretched during the passage of years. The likelihood, therefore, of painful scars due to stretching of the tissues following vertical incision would seem to be great, and this apart from any consideration of terminal neuromata, as discussed by Bancroft.¹⁰

CONCLUSION

To sum up the author is of the opinion that many surgeons fail to realize the benefits, in so far as immediate post-operative comfort and

relative freedom from post-operative pulmonary complications and wound disruption, as well as ultimate protection from weak and painful wounds, that the physiologic transverse incision confers in consequence of lack of appreciation, on their part, of certain fundamental features governing the placement and fashioning of the incision. At the risk of restatement I wish, therefore, to tabulate what I believe to be the important features in this regard.

1. It should be determined before operation whether operative procedures within the abdomen are to be carried out chiefly above or below the umbilicus and chiefly to right or left of the mid-line in order that the incision should be properly placed.

2. Whether the incision is to be above or below the umbilicus, it should never be made farther away from this structure than, at most, 2.5 cm. (1 inch). If the incision be placed farther away from the umbilicus a sufficiently long incision may not be possible in consequence of the fact that either the rib border or the pelvic bone is encountered.

3. Although most cholecystectomies and all appendectomies can be easily performed without division of the rectus muscle, no attempt should be made to save this structure at the expense of inadequate exposure. Sound healing of the rectus muscle can be expected in all cases except, perhaps, occasionally in the presence of cachexia or phagedenic infection.

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