ANATOMY OF APPROACH TO THE ABDOMEN.

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There is no muscle in the body whose exact anatomy concerns the surgeon so frequently and in so many important ways as does the rectus abdominis. Some operations on the kidney invoke an approach peculiar to that organ, the gall-bladder invites attack by an oblique incision below and parallel to the right costal margin, but with these exceptions, it is safe to say that the majority of major operations on the abdominal contents demand an incision which implicates the rectus abdominis. Even the many strange and ingenious incisions for operations on the gall-bladder, sanctioned by custom and by the names of illustrious surgeons of the past, are becoming suspect, and are giving way to the simple paramedian approach. The penalties attaching to these fundamentally unsound methods are less serious than those that follow departures from the median or paramedian incision in the lower abdomen.

Anatomy.

The attachments of the rectus to the 5th, 6th and 7th costal cartilages with a slip from the xiphisternum above, and to the pubic crest below, are liable to certain variations detailed in textbooks on anatomy and are of little or no importance to the surgeon. In the post-umbilical portion many muscle fibres are attached to the fibrous median raphe, rendering separation difficult except by dissection; this obtains in muscular subjects especially.

There are three constant transverse intermuscular septa—one opposite the xiphoid cartilage, one just below the level of the umbilicus, one half-way between these two. Not infrequently there is a fourth, usually imperfect and confined to the inner half of the muscle, half-way between the umbilicus and the pubic crest. Very rarely there is a fifth, but this is always very imperfect. These transverse fibrous septa are closely adherent to the anterior layer of the rectus sheath, but although Cunningham states that there is no attachment to the posterior layer this is not strictly correct, since in most cases it will be found that on the inner side there is close and firm attachment to the posterior layer for about ½ inch, a matter of some importance because the muscle is anchored thereby to the posterior layer and safeguarded to some extent against displacement outwards with the formation of ventral incisinal hernia. In entering the abdomen it is unnecessary and unwise to free the rectus from this attachment.

The blood supply of the muscle (Bourgery, Anatomie de l'homme) is from the lower six intercostal arteries, with branches from the upper two lumbar arteries, branches from the circumflex iliac and from the superficial external pudic, all entering the outer margin. No arteries enter the inner margin except from the superior and the inferior (or deep) epigastric. The superior epigastric prolongs from the internal mammary and emerging from beneath the costal margin enters the deep surface of the rectus and supplies the upper two-thirds of the portion above the level of the umbilicus, anastomosing in the substance of the muscle with the inferior epigastric which supplies the lower one-third of the upper portion and all the post-umbilical portion.
The superior epigastric artery below the level of the costal margin gives off two perforating arteries which run inwards and then perforate the muscle at the levels of the lineæ transversæ. The main vessel inosculates in the lower third of the supra-umbilical portion of the rectus, with the inferior epigastric artery. The inferior epigastric artery arising from the femoral artery passes internal to the internal inguinal ring, reaches the outer edge of the rectus beneath which it slips by piercing the sheath and then lies between the posterior aspect of the muscle and the fascial sheet which represents the lower part of the posterior rectus sheath. It is usually situated about mid-way between the inner and outer margins of the muscle, but it sometimes runs close to the inner margin of the muscle and thus it is in peril of injury when the muscle is retracted outwards during the operation of laparotomy by the paramedian incision. Two perforating branches corresponding to the two inconstant fibrous septa are indicated on the left rectus in Figure 1. Immediately before the artery reaches the semilunar fold, a large constant branch passes obliquely upwards and inwards towards the umbilicus, piercing the posterior layer, opposite the constant, well developed linea transversa below the level of the umbilicus and then enters the subperitoneal anastomosis around the umbilicus. This branch is usually so large that it requires ligature. Occasionally it is quite small and negligible.

![Dissection of recti abdominis.](image)

The main artery then crosses the semilunar fold and usually enters the substance of the rectus muscle; a large branch, sometimes the bulk of the artery, comes to lie on the deep surface of the muscle, and at the level of the umbilicus gives off another large branch which passes internally, quickly piercing the posterior rectus sheath to contribute to the subperitoneal anastomosis around the umbilicus.
The remainder of the artery is then distributed to the lower one-third of the part of the muscle that lies between the umbilicus and the costal margin.

In Figure 1 on the right side the rectus muscle has been removed leaving the posterior sheath. The position of the semilunar "fold" (or rather thickening) is shown; below, continuous with this layer of the sheath is a sheet of fascia which is always present, often strongly developed, and extending from the semilunar fold to the pubes. The main fibres run transversely; when a longitudinal incision is made the edges of the incision retract. Referring to the usual description of the "semilunar fold" marking the limit of the posterior sheath of the rectus, Maylard, A. E. (Practice and Problem in Abdominal Surgery, 1913, p. 32), writes: "This fold, however, is by no means constant for in operating one constantly finds that the aponeurosis behind the rectus extends down to the pubes, forming thereby a sheath for the recti for their whole extent."

The nerve supply from the last six intercostal (dorsal) nerves and a twig from the first lumbar via the ileohypogastric enters the outer aspect of the muscle. The pyramidalis receives branches from T2 D and T L, sometimes from T L and 2 L or from 2 L alone. The nerves are connected with one another by loops before reaching the rectus, but once the nerves enter the muscle there is no connection between adjacent nerves; in other words the nerve supply is strictly segmental. Prof. J. K. Jamieson says: "As there is no equivalent to anastomosis within the muscle, this (analogy with arterial supply) cannot be the case; if motor nerves are cut some muscle fibres lose their supply irretrievably" (private communication). Therefore, although injury to an individual nerve some distance from the edge of the rectus does not necessarily cause complete paralysis of any part of the muscle, injury close to the point of entry into the edge of the muscle must cause paralysis of that segment.

The 7th D supplies the segment above the xiphisternal linea transversa, the 8th D supplies the next, the 9th the next, and the portion caudal to the umbilical linea is supplied by the 10th, 11th and 12th D. These last three approach the muscle very obliquely. Now the pararectal or Battle incision is placed along the outer margin of the rectus below or posterior to the umbilicus and it is claimed, by those who still practice that approach, that the entering nerves do not suffer trauma, but the distances between the contiguous nerves are as indicated in Figure 1—between 9 and 10 D, 1 inch; between 10 and 11 D, 1 inch; and between 11 and 12 D, 2 inches. These figures are the average of a large number of observations made some years ago, on adult subjects and will be found to be approximately accurate. In the figure the parts are not drawn to scale. A certain amount of room can be obtained by displacing nerves, but it is evident that the operator is obliged to work through an incision more limited than is surgically sound to remove an appendix.

The nerves lie on the transversalis muscle beneath the external oblique until they reach the edge of the rectus and there they pierce the tendinous expansion of the internal oblique to reach the rectus muscle. In the latter they pursue a curved path as indicated in Figure 2. It will be seen that no injury to any part of the nerve can occur when the paramedian incision is made (as shown on the right-hand side of the drawing), but if an approach is made through the muscle, as in a muscle-splitting operation, some damage to the nerve is inevitable.
In Figure 2 also is shown the usual situation of the main trunk of the deep epigastric artery which stands in danger of injury and consequent post-operative haematoma, also the path of a large branch which curls round the inner edge and which can be avoided by keeping the edge of the scalpel close to fascia as the inner flap is raised.

![Cross-section of recti, showing course of nerves and arteries.](image)

**FIG. 2. Cross-section of recti, showing course of nerves and arteries.**

**The Paramedian Incision.**

It is one of the minor advantages of the paramedian approach that the incision can be made a bloodless one; that it can be made without any damage to nerves is a major consideration. The branches of the epigastric artery which pass directly into the substance of the rectus muscle are not indicated. The path by which entrance to the abdominal cavity by the paramedian incision is shown by the dotted line (Fig. 2). The extent of the incision will vary according to the operation undertaken. The skin bleeds more profusely in the neighbourhood of the umbilicus and also in the vicinity of the pubes (from the superficial external pudic artery). The perforating arteries can be caught usually before division. In retracting outwards the inner edge of the rectus injury to the one or other epigastric artery can be inflicted if the fingers are curled around the edge and especially the inferior epigastric, since it runs not infrequently close to the inner edge of the muscle. The large branch running obliquely upwards towards the umbilicus is usually worthy of ligation and division before the peritoneum is opened. The division of the posterior layer of the sheath together with the peritoneum is made between forceps, preferably in the upper part of the wound, because the underlying bowel is there more certainly protected from injury by the overlaying great omentum, especially when the small gut is distended; by lifting up this layer and cutting at the moment of maximum inspiration the risk of inflicting damage on the abdominal contents is minimised.

The subumbilical paramedian incision is the accepted invariable approach to all operations on the pelvic organs, including a "pelvic appendix." A notable exception is in the removal of a stone impacted in the ureter, where the desirability of a retroperitoneal approach warrants the regrettable injury inflicted on the muscles.

The long-accepted gridiron incision was the faith of the last generation of surgeons; to-day it is becoming a heresy of historical interest only. It is a heresy that dies hard, and lately, by a sort of artificial respiration, has threatened to be resuscitated.
The base of the appendix, the real objective in the operation of appendicectomy, lies nearer to the middle line than is commonly supposed. This is well seen in a coronal section of the abdomen, a drawing of which is reproduced here by the courtesy of the Pathological Museum of Queen's College, Belfast (Fig. 3). It is in fact approximately in line with the right ovary, but the gynaecologist would never dream of removing a small ovarian cyst with torsion of its pedicle by a gridiron incision.

Attractive and meretricious arguments advanced by the advocates of a gridiron incision are ease of accessibility and the craving to acquire merit by leaving a tiny scar. It may be conceded that that approach is excellent for a cæcostomy or for the removal of a perfectly normal appendix!

When a localized abscess has formed the evacuation of pus by the most direct route is justifiable and that abscess may be:

1. Around the cæcum in the right iliac fossa, not necessarily in the conventional “gridiron” position; often it is just internal to the anterior superior iliac spine.
2. In the right loin, a rectoceleal or perirenal abscess.
3. Above or below the right side of the diaphragm in Morison's pouch.
4. In the right chest (empyema).
5. In the pelvis where evacuation may be best achieved through the bowel or vagina.
6. In the left loin.
7. In the sac of a right inguinal hernia.

Opening an abscess following the dictates of the surgeon's clinical sense is merely dealing with a late complication of appendicitis; for the removal of the diseased appendix, i.e., appendicectomy, the paramedian incision remains the counsel of perfection.

The following considerations conspire to make the paramedian the standard method of approach to operations on the lower abdomen:

i. The uncertainty of any invariable diagnostic precision, which is only claimed by the very young or very arrogant. It is no reflection on the acumen of a surgeon to confess that he has failed to differentiate on occasion between an acute appendicitis and a perforated duodenal ulcer, torsion of the pedicle of a small right ovarian tumour in a young girl; an inflamed Meckel's diverticulum, perforation of a diverticulitis, a suppurating mesenteric gland; these are some of the conditions whose mimicry of appendicitis can deceive the most wary.

2. Where the infection has not transgressed the peritoneal covering of the appendix, a gridiron incision denies to the surgeon any opportunity of exploring neighbouring organs. A recent case in point was the discovery of gallstones in a patient who had a "carcinogenic tumour" of the appendix, the gall bladder symptoms being at the moment in abeyance.

3. Inadequate drainage of the pelvis.

4. Damage to the iliohypogastric or 12th dorsal nerve especially from infection of the surrounding tissues where drainage has been prolonged. From this it is believed by many that a greater tendency to right inguinal hernia results.

5. The pararectal or Battle incision labours under the disadvantage that the distance between adjoining nerve trunks is restricted to about 2½ inches and the incision cannot be safely extended upwards or downwards.

The laying down of rigid rules, which shackle the exercise of the clinical sense, can prove dangerous; the wise surgeon will rely on established surgical principles and careful observation. I believe that the establishing of the paramedian incision as the standard method of approach in the operation of appendicectomy, only to be varied under special circumstances, will become more universal by a fuller consideration of these surgical principles.
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