

Surgical Incisions—Their Anatomical Basis

Part IV-Abdomen

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Abstract. *The present paper is a continuation of the previous ones by Patnaik et al 2000 a, b & 2001. Here the anatomical basis of the various incisions used in anterior abdominal wall their advantages & disadvantages are discussed. An attempt has been made to add the latest modifications in a concised manner.*

Key words : *Surgical Incisions, Abdomen, Midline, Paramedian, McBurney, Gridison, Kocher.*

Introduction :

It is probably no exaggeration to state that, in abdominal surgery, wisely chosen incisions and correct methods of making and closing such wounds are factors of great importance (Nygaard and Squatrito, 1996). Any mistake, such as a badly placed incision, inept methods of suturing, or ill-judged selection of suture material, may result in serious complications such as haematoma formation, an ugly scar, an incisional hernia, or, worst of all, complete disruption of the wound (Pollock, 1981; Carlson et al, 1995).

Before the advent of minimally invasive techniques, optimal access could only be achieved at the expense of large high morbidity incisions. Endoscopic and laparoscopic technology has, however revolutionized these concepts facilitating patient friendly access to even the most remote of abdominal organs (MacIntyre, 1994).

It should be the aim of the surgeon to employ the type of incision considered to be the most suitable for that particular operation to be performed. In doing so, three essentials should be achieved (Zinner et al, 1997):

1. Accessibility
2. Extensibility
3. Security

The incision must not only give ready and direct access to the anatomy to be investigated but also provide sufficient room for the operation to be performed (Velanovich, 1989). The incision should

be extensible in a direction that will allow for any probable enlargement of the scope of the operation, but it should interfere as little as possible with the functions of the abdominal wall. The surgical incision and the resultant wound represent a major part of the morbidity of the abdominal surgery.

Planning of an abdominal incision :

In the planning of an abdominal incision, Nyhus & Baker (1992) stressed that the following factors must be taken into consideration (a) pre-operative diagnosis (b) the speed with which the operation needs to be performed, as in trauma or major haemorrhage, (c) the habitus of the patient, (d) previous abdominal operation, (e) potential placements of stomas (Funt, 1981; Telfer et al, 1993). Ideally, the incision should be made in the direction of the lines of cleavage in the skin so that a hairline scar is produced.

The incision must be tailored to the patients need but is strongly influenced by the surgeon's preference. In general, re-entry into the abdominal cavity is best done through the previous laparotomy incision. This minimizes further loss of tensile strength of the abdominal wall by avoiding the creation of additional fascial defects (Fry & Osler, 1991).

Care must be taken to avoid 'tramline' or 'acute angle' incisions (Figure 1), which could lead to devascularisation of tissues. It is also helpful if incisions are kept as far as possible from established or proposed stoma sites and these

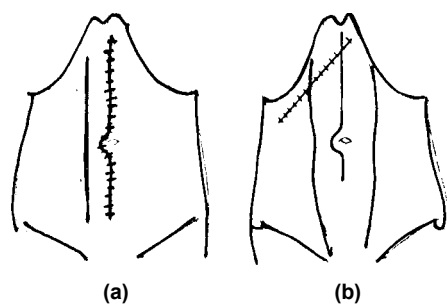


Fig. 1. (a) Tramiline Incision. (b) Acute angle incision.

stomas should be marked preoperatively with skin marking pencils to avoid any mistakes (Burnand & Young, 1992).

Cosmetic end results of any incision in the body are most important from patients' point of view. Consideration should be given wherever possible, to siting the incisions in natural skin creases or along Langer's lines. Good cosmesis helps patient morale.

Much of the decision about the direction of the incision depends on the shape of the abdominal wall. A short, stocky person sometimes has a longer incision and frequently better exposure, if the incision is transverse. A tall, thin, asthenic patient has a short incision if it is made transversally, whereas a vertical incision affords optimal exposure (Greenall et al, 1980).

Certain operations are ideally done through a transverse or subcostal incision, for example cholecystectomy through a right Kocher's incision, right hemicolectomy through an infraumbilical transverse incision, and splenectomy through a left subcostal incision. Vagotomy and antrectomy can be done through a bilateral subcostal incision with a longer right and shorter left extension if the patient is stocky or obese (Grantcharov & Rosenberg, 2001).

Certain incisions, popular in the past, have been abandoned, and appropriately so. One example of this is the para-rectus incision made at the lateral border of the rectus sheath. This incision was used until the mid 1940 primarily for the removal of the gall bladder, the spleen, and the left colon. It denervates the rectus muscle and produces an ideal environment for the development of postoperative ventral hernia, and has absolutely nothing to recommend it (Nyhus & Baker, 1992).

Classification of incisions :

The incisions used for exploring the abdominal cavity can be classified as :

- (A) Vertical incision : These may be
 - (i) Midline incision
 - (ii) Paramedian incisions
- (B) Transverse and oblique incisions :
 - (i) Kocher's subcostal Incision
 - (a) Chevron (Roof top Modification)
 - (b) Mercedes Benz Modification
 - (ii) Transverse Muscle dividing incision
 - (iii) Mc Burney's Grid iron or muscle splitting incision
 - (iv) Oblique Muscle cutting incision
 - (v) Pfannenstiel incision
 - (vi) Maylard Transverse Muscle cutting Incision
- (C) Abdominothoracic incisions

A. Vertical incisions :

Vertical incisions include the midline incision, paramedian incision, and the Mayo-Robson extension of the paramedian incision.

(i) Midline Incision (Figure 2) :

Almost all operations in the abdomen and retroperitoneum can be performed through this universally acceptable incision (Guillou et al, 1980). **Advantages** (a) It is almost bloodless, (b) no muscle fibres are divided, (c) no nerves are injured, (d) it affords goods access to the upper abdominal viscera, (e) It is very quick to make as well as to close; it is unsurpassed when speed is essential (Clarke, 1989) (f) a midline epigastric incision also can be extended the full length of the abdomen curving around the umbilical scar (Denehy et al, (1998).

In the upper abdomen, the incision is made in the midline extending from the area of xiphoid and ending immediately above the umbilicus (Ellis, 1984). Skin, fat, linea alba and peritoneum are divided in that order. Division of the peritoneum is best performed at the lower end of the incision, just above the umbilicus so that falciform ligament can

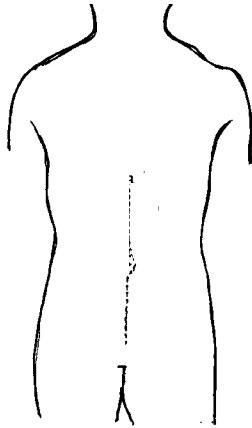


Fig. 2. Midline Incision

be seen and avoided. If necessary for exposure, the ligament can be divided between clamps and ligated. A few centimeters of upwards extension can be gained by extending the incision to either side of the xiphoid process, or actually excising the xiphoid (*Didolkar & Vickers, 1995*). The extraperitoneal fat is abundant and vascular in this area, and small vessels here need to be coagulated with diathermy.

The infraumbilical midline incision also divides the linea alba. Because the linea alba is anatomically narrow at the inferior portion of the abdominal wall, the rectus sheath may be opened unintentionally, although this is of no consequence. In the lower abdomen, the peritoneum should be opened in the uppermost area to avoid possible injury to the bladder.

It is a good practice to place a bladder catheter before any surgery on the lower abdomen and to curve the properitoneal and peritoneal incisions laterally when approaching the pubic symphysis to avoid entry into the bladder (*Nyhus & Baker, 1992*).

Special care is needed when operating on patients with intestinal obstruction or when re-exploring following previous abdominal surgery (*Fry & Osler, 1991*). In intestinal obstruction, distended bowel loops may be there immediately below the incision and in re-exploration, the bowel may be adherent to the peritoneum. The way to avoid this is to open the peritoneum in a virgin area at the upper or lower part of the incision (*Levrant et al, 1994*).

(ii) Paramedian Incision (Figure 3)

The paramedian incision has two theoretical

advantages. The first is that it offsets the vertical incision to the right or left, providing access to the lateral structures such as the spleen or the kidney. The second advantage is that closure is theoretically more secure because the rectus muscle can act as a buttress between the reapproximated posterior and anterior fascial planes (*Cox et al, 1986*).

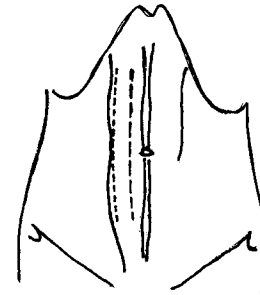


Fig. 3. Paramedian Incisions

The skin incision is placed 2 to 5 cm lateral to the midline over the medial aspect of the bulging transverse convexity of the rectus muscle. Extra access can be obtained by sloping the upper extremity of the incision upwards to the xiphoid (*Didolkar et al, 1995*).

Skin and subcutaneous fat are divided along the length of the wound. The anterior rectus sheath is exposed and incised, and its medial edge is grasped and lifted up with haemostats. The medial portion of the rectus sheath then is dissected from the rectus muscle, to which the anterior sheath adheres. Segmental blood vessels encountered during the dissection should be coagulated. Once the rectus muscle is free of the anterior sheath it can be retracted laterally because the posterior sheath is not adherent to the rectus muscle. The posterior sheath and the peritoneum which are adherent to each other, are excised vertically in the same plane as the anterior fascial plane (*Brennan et al, 1987*). The deep inferior epigastric vessels are encountered below the umbilicus and require ligation and division if they course medially along the line of the incision (*Chuter et al, 1992*).

A paramedian incision below the umbilicus is made in a similar manner. The only difference is that inferior epigastric vessels are exposed in the posterior compartment of the rectus sheath and the transversalis fascia is found in the anterior fascial

layer below the semicircular line of Douglas.

some surgeons still prefer to split the rectus muscle rather than dissect it free (*Guillou et al, 1980*). In this rectus-splitting technique, the muscle is split longitudinally near its medial border (medial 1/3rd or preferably one-sixth), after which posterior layer of the rectus sheath and peritoneum are opened in the same line. This incision can be made and closed quickly and is particularly valuable in reopening the scar of a previous paramedian incision. In such circumstances, it is very difficult, or indeed impossible to dissect the rectus muscle away from the rectus sheath.

Disadvantages :

1. It tends to weaken and strip off the muscles from its lateral vascular and nerve supply resulting in atrophy of the muscle medial to the incision.
2. The incision is laborious and difficult to extend superiorly as is limited by costal margin.
3. It doesn't give good access to contralateral structures.

The Mayo-Robson extension of the paramedian incision is accomplished by curving the skin incision towards the xiphoid process. Incision of the fascial planes is continued in the same direction to obtain a larger fascial opening (*Pollock, 1981*).

(B) Transverse Incisions (Figure 4)

Transverse incisions include the Kocher

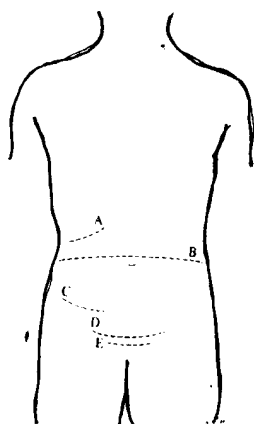


Fig. 4. Transverse and transverse-oblique Incisions. A. Kocher incision. B. Transverse Incision. C. Rockey-Davis incision. D. Maylard incision. E. Pfannenstiel incision

subcostal incision, transverse muscle dividing, McBurney, Pfannenstiel, and Maylard incisions.

(i) Kocher subcostal incision (Figure 5)

Theodore Kocher originally described the subcostal incision; it affords excellent exposure to the gall bladder and biliary tract and can be made on the left side to afford access to the spleen (*Kocher, 1903*). It is of particular value in obese and muscular patients and has considerable merit if diagnosis is known and surgery planned in advance.

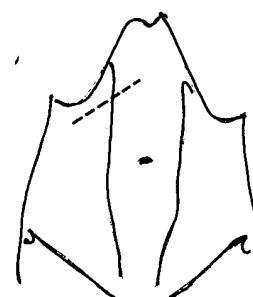


Fig. 5. Kocher's Incision

The subcostal incision is started at the midline, 2 to 5 cm below the xiphoid and extends downwards, outwards and parallel to and about 2.5 cm below the costal margin (*Hardy 1993; Dorfman et al, 1997*). Extension across the midline and down the other costal margin may be used to provide generous exposure of the upper abdominal viscera. The rectus sheath is incised in the same direction as the skin incision, and the rectus muscle is divided with cautery; the internal oblique and transversus abdominis muscles are divided with cautery. Some authors have described the retraction of rectus muscle instead of dividing it (*Brodie et al, 1976; Fink & Budd, 1984*).

Special attention is needed for control of the branches of the superior epigastric vessels, which lie posterior to and under the lateral portion of the rectus muscle. The small eighth thoracic nerve will almost invariably be divided; the large ninth nerve must be seen and preserved to prevent weakening of the abdominal musculature. The incision is deepened to open the peritoneum (*Dorfman et al, 1997*).

In the recent years, many surgeons have advocated the use of a small 5-10 cm incision in the subcostal area for cholecystectomy - mini-lap

cholecystectomy (Seenu & Misra, 1994). This incision is similar to the Kocher's incision except for the length of the incision. The major advantages of this incision are lesser postoperative pain, early recovery from the surgery and return to work and good cosmetic results (Coelho *et al*, 1993). But disadvantage is less exposure, which can be dangerous in cases of difficult anatomy or lot of adhesions and chances of injury to bile ducts or other structures (Kopelman *et al*, 1994; Gupta *et al*, 1994).

(a) Chevron (Roof Top) Modification :

The incision may be continued across the midline into a double Kocher incision or roof top approach (Chevron Incision) (Figure 6), which provides excellent access to the upper abdomen particularly in those with a broad costal margin (Chute *et al*, 1968; Brooks *et al*, 1999). This is useful in carrying out total gastrectomy, operations for renovascular hypertension, total oesophagectomy, liver transplantation, extensive hepatic resections, and bilateral adrenalectomy etc (Chino & Thomas, 1985; Pinson *et al*, 1995; Miyazaki *et al*, 2001).

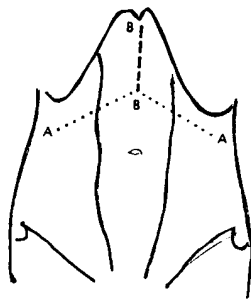


Fig. 6. A.: Rooftop incision; B.: Mercedes Benz extension

(b) The Mercedes Benz Modification : (Fig. 6)

Variant of this incision consists of bilateral low Kocher's incision with an upper midline limb up to and through the xiphisternum (Sato *et al*, 2000). This gives excellent access to the upper abdominal viscera and, in particular to all the diaphragmatic hiatuses (Yoshinaga, 1969; Motsay *et al*, 1973; Brooks *et al*, 1999).

The rectus muscle can be divided transversely. Its anterior and posterior sheaths are closed without any serious weakening of the abdominal muscle

because the incision passes between adjacent nerves without injuring them. The rectus muscle has a segmental nerve supply, so there is no risk of a transverse incision depriving the distal part of the rectus muscle of its innervation. Healing of the scar, in effect, simply results in the formation of a man made additional fibrous intersection in the muscle (Pemberton and Manaz, 1971).

(ii) Transverse Muscle-dividing incision (Figure 6)

The operative technique used to make such an incision is similar to that for the Kocher incision. In newborns and infants, this incision is preferred, because more abdominal exposure is gained per length of the incision than with vertical exposure because the infant's abdomen has a longer transverse than vertical girth (Gauderer, 1981). This is also true of short, obese adults, in whom transverse incision often affords a better exposure.

(iii) McBurney Grid iron or Muscle-split incision (Figure 7)

The McBurney incision, first described in 1894 by Charles McBurney is the incision of choice for most appendicectomies (McBurney, 1894). The level and the length of the incision will vary according to the thickness of the abdominal wall and the suspected position of the appendix (Jelenko & Davis 1973; Watts & Perrone, 1997). Good healing and cosmetic appearance are virtually always achieved with a negligible risk of wound disruption or herniation.

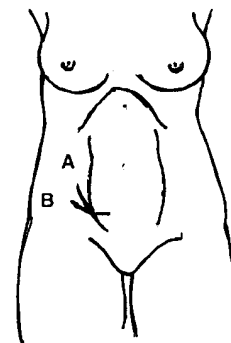


Fig. 7. Surface markings of the right iliac fossa appendicectomy incision. A. The Classic McBurney incision is obliquely placed. B. Most surgeons today use a more transverse skin-crease incision

Classically, the McBurney incision is made at the junction of the middle third and outer thirds of a

line running from the umbilicus to the anterior superior iliac spine, the McBurney point (Watts, 1991). However, if palpation reveals a mass, the incision can be placed directly over the mass. McBurney originally placed the incision obliquely, from above laterally to below medially. However, the skin incision can be placed in a skin crease transversely [Rockey-Davis Incision (Fig 4c) or Lanz Incision or Bikini Incision], which provides a better cosmetic result (Delany & Carnevale, 1976; Pleterski & Temple, 1990). Otherwise, the two incisions are similar.

If it is anticipated that it may be necessary to extend the incision, then the incision should be placed obliquely, which enables it to be extended laterally as a muscle splitting incision (Losanoff & Kjossev, 1999).

After the skin and subcutaneous tissue are divided, the external oblique aponeurosis is divided in the direction of its fibres; exposing the underlying internal oblique muscle. A small incision is then made in this muscle adjacent to the outer border of the rectus sheath. The opening is enlarged to permit introduction of two index fingers between the muscle fibres so that internal oblique and transversus can be retracted with a minimal amount of damage. The peritoneum is then grasped with a thumb forceps, elevated and opened.

If further access is required, the wound can be easily enlarged by dividing the anterior sheath of the rectus muscle in line with the incision, after which rectus muscle is retracted medially (Jelenko & Davis, 1973; Moneer, 1998). Wide lateral extension of the incision can be affected by combination of division and splitting of the oblique muscles along the line of their fibres in the lateral direction (Weir extension) (Askew, 1975).

This incision also may be used in the left lower quadrant to deal with certain lesions of the sigmoid colon, such as drainage of a diverticular abscess.

The ilioinguinal and iliohypogastric nerves cross the incision for appendectomy and their accidental injury should be prevented which can predispose the patient to inguinal hernia formation in the postoperative period (Mandelkow & Loeweneck, 1988).

(iv) Oblique Muscle-cutting incision

This incision bears the eponym of the Rutherford-Morrison incision (Talwar et al, 1997). This is extension of the McBurney incision by division of the oblique fossa and can be used for a right or left sided colonic resection, caecostomy or sigmoid colostomy.

(v) Pfannenstiel incision (Figure 4)

The Pfannenstiel incision is used frequently by gynaecologists and urologists for access to the pelvis organs, bladder, prostate and for caesarean section (Ayers & Morley, 1987; Mendez et al, 1999; Hendrix et al, 2000). The skin incision is usually 12 cm long and is made in a skin fold approximately 5 cm above symphysis pubis. The incision is deepened through fat and superficial fascia to expose both anterior rectus sheaths, which are divided along the entire length of the incision. The sheath is then separated widely, above and below from the underlying rectus muscle. It is necessary to separate the aponeurosis in an upward direction, almost to the umbilicus and downwards to the pubis. The rectus muscles are then retracted laterally and the peritoneum opened vertically in the midline, with care being taken not to injure the bladder at the lower end.

The incision offers excellent cosmetic results because the scar is almost always hidden by the patient's pubic hair postoperatively (Griffiths, 1976). Because the exposure is limited this incision should be used only when surgery is planned on the pelvic organs (Mendez et al, 1999).

(vi) Maylard Transverse Muscle Cutting Incision (Figure 4)

Many surgeons prefer this incision because it gives excellent exposure of the pelvic organs (Helmkamp & Kreb, 1990; Brand, 1991). The skin incision is placed above but parallel to the traditional placement of Pfannenstiel incision. The rectus fascia and muscle are then cut transversely, and the incision is continued laterally as far as necessary, dividing external and internal oblique muscles; the transverses abdominis and transversalis fascia are opened in the direction of their fibres.

(C) Thoracoabdominal Incision (Figures 8 & 9)

The thoracoabdominal incision, either right or left, converts the pleural and peritoneal cavities into one common cavity and thereby gives excellent exposure. Laparotomy incisions, whether upper midline, upper paramedian or upper oblique can be easily extended into either the right or left chest for better exposure (Nyhus & Baker, 1992).

The right incision may be particularly useful in elective and emergency hepatic resections (Kise *et al*, 1997). The left incision may be used effectively in resection of the lower end of the esophagus and proximal portion of the stomach (Molina *et al*, 1982; Ti, 2000).

When liver resection is anticipated, it is now more common to give a sternum splitting incision than to extending it into the right pleural space (Sato *et al*, 2000). The reasons for this are that the sternum heals with considerably less pain than does the costochondral junction; the exposure is as good, and the intrapericardial vena cava can be controlled through this incision if there is untoward venous bleeding (Miyazaki *et al*, 2001).

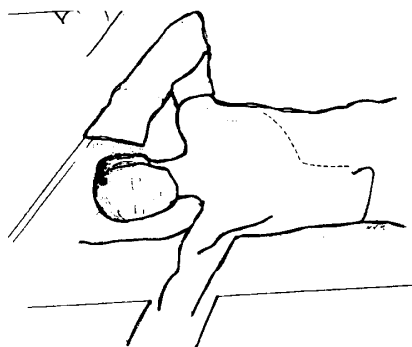


Fig. 8. "Corkscrew" position for throaco abdominal incision

The patient is placed in the "cork-screw" position. (Fig. 8) The abdomen is tilted about 45° from the horizontal by means of sand bags, and the thorax twisted into fully lateral position. This position allows maximal access to both abdomen and the thoracic cavity (Morrissey & Hollier, 2000). The abdomen is explored first through the abdominal incision to assess for the operative exposure and necessity for thoracic extension. The incision is extended along the line of the eighth interspace, the space immediately distal to the inferior pole of the scapula (Dudley, 1983). (Fig. 9)

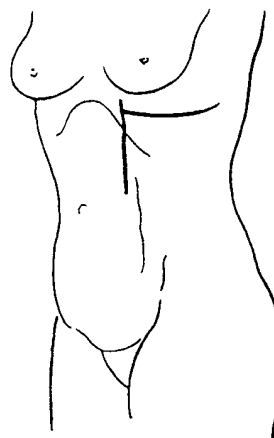


Fig. 9. Surface markings of the thoracoabdominal incision

The thoracic incision is carried down through the subcutaneous fat and the latissimus dorsi, serratus anterior and external oblique muscles. The intercostals muscles are divided with cautery and pleural cavity is opened and lung allowed to collapse. The incision is continued across the costal margin, and the cartilage is divided in a V shape manner with a scalpel so that the two ends interdigitate and can be closed more securely. A chest retractor is inserted and opened to produce wide spreading of the intercostal space. After ligation of the phrenic vessels in the line of the incision, the diaphragm is divided radially (Zinner *et al*, 1997).

References :

1. Askew, A.R. (1975) : The Fowler-Weir approach to appendicectomy. *British Journal of Surgery*, **62**(4): 303-4.
2. Ayers, J.W., Morley, G.W. (1987): Surgical incision for caesarean section. *Obstetrics Gynaecology*, **70**(5): 706-8.
3. Brand, E. (1991): The Cherney incision for gynaecologic cancer. *American Journal of Obstetrics and Gynaecology*, **165**(1): 235.
4. Brennan, T.G., Jones, N.A., Guillou, P.J. (1987): Lateral paramedian incision. *British Journal of Surgery*, **74**(8): 736-7.
5. Brodie, T.E., Jackson, J.T., McKinnon, W.M. (1976): A muscle retracting subcostal incision for cholecystectomy. *Surgery Gynaecology Obstetrics* **143**(3): 452-3.
6. Brooks, M.J., Bradbury, A., Wolfe, H.N. (1999) : Elective repair of type IV thoraco-abdominal aortic aneurysms; experience of a subcostal (transabdominal) approach. *European Journal of Vascular Endovascular Surgery*, **18**(4): 290-3.
7. Burnand, K.G., Young, A.E.: The New Aird's Companion in Surgical Studies. Churchill Livingstone Edinburgh (1992).
8. Carlson, M.A., Ludwig, K.A., Condon, R.E. (1995): Ventral hernia and other complications of 1,000 midline incisions. *Southern Medical Journal* **Apr**; **88**(4): 450-3.

9. Chino, E.S., Thomas, C.G. (1985): An extended Kocher incision for bilateral adrenalectomy. *American Journal of Surgery*, **149**(2): 292-4.
10. Chute, R., Baron, J.A. Jr., Olsson, C.A. (1968): The transverse upper abdominal "chevron" incision in urological surgery. *Journal of Urology*, **99**(5): 528-32.
11. Chuter, T.A., Steinberg, B.M., April, E.W. (1992): Bleeding after extension of the midline epigastric incision. *Surgery Gynaecology Obstetrics*, **174**(3): 236.
12. Clarke, J.M. (1989): Case for midline incisions. *Lancet*, **Mar 18; 1 (8638)**: 622.
13. Coelho, J.C., de Araujo, R.P., Marchensini, J.B., Coelho, I.C., de Araujo, L.R. (1993): Pulmonary function after cholecystectomy performed through Kocher's incision, a mini-incision, and laparoscopy. *World Journal of Surgery*, **17**(4): 544-6.
14. Cox, P.J., Ausobsky, J.R., Ellis, H., Pollock, A.V. (1986): Towards no incisional hernias: lateral paramedian versus midline incisions. *Journal of Royal Society of Medicine*, **Dec. 79**(12): 711-12.
15. Delany, H.M., Carnevale, N.J. (1976): A "Bikini" incision for appendectomy. *American Journal of Surgery*, **132**(1): 126-27.
16. Denehy, T.R., Einstein, M., Gregori, C.A., Breen, J.L. (1998): Symmetrical periumbilical extension of a midline incision: a simple technique. *Obstetrics Gynaecology* **91**(2): 293-94.
17. Didolkar, M.S., Vickers, S.M. (1995): Perixiphoid extension of the midline incisions. *Journal of American College of Surgery*, **180**(6): 739-41.
18. Dorfman, S., Rincon, A., Shortt, H. (1997): Cholecystectomy via Kocher incision without peritoneal closure. *Investigation Clinics*, **38**(1): 3-7.
19. Dudley, H.: Robe and Smith's Operative Surgery. In: Alimentary Tract and abdominal wall. Volume 1 General Principles, 4th edn. Butterworths London: (1983).
20. Ellis, H. (1984): Midline abdominal incisions. *British Journal of Obstetrics and Gynaecology*, **91**(1): 1-2.
21. Fink, D.L., Budd, D.C. (1984): Rectus muscle preservation in oblique incisions for cholecystectomy. *American Journal of Surgery*, **50**(11): 628-36.
22. Fry D.E., Osler, T. (1991): Abdominal wall considerations and complications in reoperative surgery. *Surgery Clinics of North America*, **71**(1): 1-11.
23. Funt, M.I. (1981): Abdominal incisions and closures. *Clinical Obstetrics Gynaecology*, **24**(4): 1175-85.
24. Gauderer, M.W.L. (1981): A rationale for the routine use of transverse abdominal incision in infants and children. *Journal of Paediatric Surgery* **16** (Sup.1): 583.
25. Grantcharov, T.P., Rosenberg, J. (2001): Vertical compared with transverse incision in abdominal surgery. *European Journal of Surgery*, **167**(4): 260-7.
26. Greenall, M.J., Evans, M., Pollock, A.V. (1980): Midline or transverse laparotomy ? A random controlled clinical trial. Part I: Influence on healing. *British Journal of Surgery*, **67**(3): 188-90.
27. Griffiths, D.A. (1976): A reappraisal of the Pfannenstiel incision. *British Journal of Urology*, **46**(6): 469-74.
28. Guillou, P.J., Hall, T.J., Donaldson, D.R., Broughton, A.C., Brennan, T.G. (1980): Vertical abdominal incisions - a choice ? *British Journal of Surgery*, **67**(6): 395-9.
29. Gupta, S., Elanogovan, K., Coshic, O., Chumber, S. (1994): Minicholecystectomy: can we reduce it further ? *Journal of Surgery Oncology*, **56**(3): 167.
30. Hardy, K.J. (1993): Carl Langenbuch and the Lazarus Hospital: events and circumstances surrounding the first cholecystectomy. *Australian Journal of surgery*, **63**(1): 56-64.
31. Helmkamp, B.F., Krebs, H.B. (1990): The Maylard incision in gynaecologic surgery. *American Journal of Obstetrics and Gynaecology*, **163**(5Pt.1): 1554-7.
32. Hendrix, S.L., Schimp, V., Martin, J., Singh, A., Kruger, M., McNeelay, S.G. (2000): The legendary superior strength of the pfannenstiel incision: a myth ? *American Journal of Obstetrics and Gynaecology*, **182**(6): 1446-51.
33. Jelenko C 3rd., Davis, L.P. (1973): A transverse lower abdominal appendectomy incision with minimal muscle derangement. *Surgery Gynaecology Obstetrics*, **136**(3): 451-2.
34. Kise, Y., Takayama T., Yamamoto, J., Shimada, K., Kosuge, T., Yamasaki S., Makuuchi, M. (1997): Comparison between thoracoabdominal and abdominal approaches in occurrence of pleural effusion after liver cancer surgery. *Hepatogastroenterology*, **44**(17): 1397-1400.
35. Kocher, T. Textbook of operative surgery, 2nd ed. Black London, England: (1903)
36. Kopelman, D., Schein, M., Assalia, A., Meizlin, V., Harshmonia, M. (1994): Technical aspects of minicholecystectomy. *Journal of American College of Surgery*, **178**(6): 624-5.
37. Levraut, S.G., Bieber, E., Barnes, R. (1994): Risk of anterior abdominal wall adhesions increases with number and type of previous laparotomy. *Journal of American Association of Gynaecology Laparotomy*, **1** (4, Part 2): 19.
38. Losanoff, J.E., Kjossev, K.T. (1999): Extension of McBurney's incision: old standards versus new options. *Surgery Today*, **26**(6): 584-6.
39. Mandelkow, H., Leoweneck, H. (1988): The iliohypogastric and ilioinguinal nerves. Distribution in the abdominal wall, danger areas in surgical incisions in the inguinal and pubic regions and reflected visceral pain in their dermatomes. *Surgery Radiology Anatomy*, **10**(2): 145-9.
40. MacIntyre, I.M.C.: Practical Laparoscopic Surgery for General Surgeons. Butterworth-Hennemann. Oxford: (1994)
41. McBurney, C. (1894): The incision made in the abdominal wall in cases of appendicitis, with a description of a new method of operating. *Annals of Surgery*, **20**: 38.
42. Mendez, L.E., Cantuaria, G., Angioli, R., Mirhashemi, R., Gabriel, C., Estape, R., Penalver, M. (1999): Evaluation of the Pfannenstiel incision for radical abdominal hysterectomy with pelvic and para-aortic lymphadenectomy. *International Journal of Gynaecology Cancer*, **9**(5): 418-20.
43. Miyazaki, K., Ito, H., Nakagawa, K., Shimizu, H., Yoshidome, H., Shimizu, Y., Ohtsuka, M., Togawa, A., Kimura, F. (2001): An approach to intrapericardial inferior vena cava through the abdominal cavity, without median sternotomy, for total hepatic vascular exclusion. *Hepatogastroenterology*, **48**(41): 1443-6.
44. Molina, J.E., Lawton, B.R., Myers, W.O., Humphrey, E.W. (1982): Esophagogastricomy for adenocarcinoma of the cardia. Ten years' experience and current approach. *Annals of Surgery*, **195**(2): 146-51.
45. Moneer, M.M. (1998): Avoiding muscle cutting while extending McBurney's incision: a new surgical concept. *Surgery Today*, **28**(2): 235-9.
46. Morrissey, N.J., Hollier, L.H. (2000): Anatomic exposures in thoracoabdominal aortic surgery. *Semin Vascular Surgery*, **13**(4): 283-9.

47. Motsay, G.J., Alho, A., Lillehei, R.C. (1973): Diastolic hypertension corrected by operation: a review. *Journal of Surgical Research*, **15(6)**: 433-49.
48. Nygaard, I.E., Squatrito, R.C. (1996): Abdominal incisions from creation to closure. *Obstetrics Gynaecology Surgery* **51(7)**: 429-36.
49. Nyhus, L.M. & Baker, R.J. : Mastery of Surgery In : Abdominal Wall Incisions. 2nd Edn Little Brown & Co. Boston. : 444-452 (1992).
50. Patnaik, V.V.G., Singla, R.K., Bala Sanju (2000a): Surgical Incisions-Their anatomical basis. Part-I Head & Neck. *Journal of The Anatomical Society of India* **49(1)**: pp 69-77.
51. Patnaik, V.V.G., Singla, R.K., Gupta, P.N. (2000b): Surgical Incisions-Their anatomical basis. Part-II Upper limb. *Journal of The Anatomical Society of India* **49(2)**: pp 182-190.
52. Patnaik, V.V.G., Singla, R.K., Gupta, P.N. (2001): Surgical Incisions-Their anatomical basis. Part-III Lower limb. *Journal of The Anatomical Society of India* **50(1)**: pp 48-58.
53. Pemberton, L.B., Manaz, W.G. (1971): Complications after vertical and transverse incisions for cholecystectomy. *Surgery Gynaecology Obstetrics*, **132(5)**: 892-4.
54. Pinson, C.W., Drougas, J.G., Lalikos, J.L. (1995): Optimal exposure for hepatobiliary operations using the Bookwalter self-retaining retractor. *American Journal of Surgery*, **61(2)**: 178-81.
55. Pleterski, M., Temple, W.J. (1990): Bikini appendectomy incision as an alternative to the McBurney approach for appendicitis. *Canadian Journal of Surgery*, **33(5)**: 343-5.
56. Pollock, A.V. (1981): Laparotomy. *Journal of Social Medicine* **74(7)**: 480-4.
57. Sato, H., Sugawara, Y., Yamasaki, S., Shimada, K., Takayama, T., Makuuchi, M., Kosuge, T. (2000): Thoracoabdominal approaches versus inverted T incision for posterior segmentectomy in hepatocellular carcinoma. *Hepatogastroenterology*, **47(32)**: 504-6.
58. Seenu, V., Misra, M.C. (1994): Mini-lap cholecystectomy - an attractive alternative to conventional cholecystectomy. *Tropical Gastroenterology*, **15(1)**: 29-31.
59. Talwar, S., Laddha, B.L., Jain, S., Prasad, P. (1997): Choice of incision in surgical management of small bowel perforations in enteric fever. *Tropical Gastroenterology*, **18(2)**: 78-9.
60. Telfer, J.R., Canning, G., Galloway, D.J. (1993): Comparative study of abdominal incision techniques. *British Journal of Surgery*, **Feb; 80(2)**: 233-5.
61. Ti, T.K. (2000): Surgical approach and results of surgery in adenocarcinoma of the gastro-oesophageal junction. *Singapore Medical Journal*, **41(1)**: 14-8.
62. Velanovich, V. (1989): Abdominal incision, *Lancet*, **4;1(8636)**: 508-9.
63. Watts, G.T. (1991): McBurney's point-factor or fiction. *Annals of Royal College of Surgery England*, **73(3)**: 199-200.
64. Watts, G.T., Perone, N. (1997): Appendectomy. *Southern Medical Journal*, **90(2)**: 263.
65. Yoshinaga, K. (1969): Operable hypertension. *Japanese Circ Journal*, **33(12)**: 1627-8.
66. Zinner, M.J., Schwartz, S.I., Ellis, H. Maingot's abdominal operations In: Incisions, closures and management of the wound. Ellis, H. (Edr), 10th Edn. Prentice Hall International Inc. N. Jersey, pp. 395-426. (1997).