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SURGICAL MANAGEMENT OF INCISIONAL HERNIAS; THE CURRENT STANDING

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There is no consensus as to the "ideal" operation for repair of an incisional hernia yet. Consequently, different techniques are adopted. The current techniques adopted are best grouped as follows:

1. Anatomic repair of the abdominal wall, either with layer-by-layer reconstruction or mass closure technique.
2. Overlap techniques, which are actually either vertical or transverse Mayo overlap.
3. Darn techniques using either strips of fascia lata or nylon and Maingot's keel repair, which is essentially extra-peritoneal darn of the rectus sheaths.
4. The Nutall operation.
5. Components separation of anterior abdominal wall muscles.
6. Prosthetic repair.
7. Laparoscopic repair.

Most surgeons are already familiar with the first four techniques as they have been in practice for a long time and that is why they are discussed briefly here. It's the latter three techniques that are currently under the spotlight in the repair of incisional hernia

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1) Anatomic reconstruction

a. layer by layer reconstruction

This is best suited for small to moderate sized incisional hernias especiallyr those where the gap between the opposing edges is rather narrow along its transverse axis. Scar tissue is excised freely until normal structures are identified clearly. The abdominal wall is then reconstructed as meticulously as possible through stitching the layers together individually, one by one.

b. Mass Closure

This technique is used for midline incisional hernia where the margins of the defect can be brought together without tension. It is simple and avoids opening up tissue spaces. We use strong, interrupted nonabsorbable sutures in a one layer that includes the peritoneum

and the anterior and posterior rectus sheaths.

2) Overlap Methods

a- Vertical Overlap of Rectus Sheaths

If the original incision was a paramedian or vertical muscle-splitting incision, its repair follows the following guidelines. The scar is excised entirely, skin flaps are raised to provide an easy approximation eventually, the peritoneal sac is trimmed and the edges of the peritoneum are then brought together with a continuous suture of O chromic catgut. Rectus muscle sheaths are extensively freed both longitudinally and laterally while the margins of the aponeurosis are overlapped or approximated with a series of closely applied interrupted sutures of monofilament nylon, polypropylene, or stainless steel wire. The skin edges are sutured with vertical mattress sutures of nylon. It is worth noting, however, that vertical overlap seriously hampers the mobility of the important mobile respiratory zone in the anterior abdominal wall, furthermore, it results in marked stretching of the aponeuroses in the rather narrow epigastrium, particularly in patients who have narrow costal angles.

b- Transverse Overlap

This refers essentially to the "Mayo principle" of repair which is a technique of transverse closure where the upper layer is imbricated over the lower in a "vest over pants" fashion. It is suitable for defects that are not too large in the vertical direction.

c- Cattell Operation

This is a simple method for repairing midline incisional hernias. The skin scar is excised, sac opened and the peritoneum and underlying fibrous edges of the defect are brought together using a continuous interlacing suture of strong chromic catgut. The sac is then excised 2 cm distal to the suture and its cut edges are sutured with a continuous catgut suture. An elliptical incision is made 2cm lateral to the previous suture line and the medial flaps are approximated. The muscles on either side are then approximated by interrupted sutures and the lateral aponeurotic flaps are sutured over the muscles with stainless steel wire or silk sutures. Cattell's technique is used to repair large defects or defects that reach down to the pubic bone. A recurrence rate as high as 30% is reported for large defects and defects extending down to the bone. Supplementing the procedure by a skin graft lowers recurrence to 10% only.

d- Da Silva method

Da Silva described a repair that utilizes flaps of rectus sheath and the fibroperitoneal tissue of the hernial sac itself. Three overlapping layers are fashioned to approximate the medial edges of the rectus muscles to the midline thus reducing suture line tension by its distribution through the layers. In his original article, Da Silva described a technique using flaps formed by three longitudinal incisions, to produce a three-layer overlap for repair of massive longitudinal median or paramedian incisional hernias. The first incision is made through the fibroperitoneal hernial sac after dissection of skin and subcutaneous tissue exposing the anterior rectus sheaths on both sides. The second incision is placed to the left side 1 cm lateral to the medial border of the rectus sheath in the peritoneum and posterior rectus sheath (posterior longitudinal incision). The third, and last, incision is made to the right side in the anterior rectus sheath, 1 cm lateral to its medial border. The resultant flaps are brought together by continuous sutures with the least possible tension in the following manner; The lateral edge of the left posterior incision is sutured to the right edge of the sac. The medial

edge of the right anterior incision is sutured to the medial edge of the left posterior incision by reflecting each edge towards the midline. The left sided cut edge of the sac is sutured to the lateral edge of the anterior incision. The skin is closed over a vacuum suction drain.

3) Darns

a. Nylon darn anatomical repair (Loh et al,1992*)*

Rectus-relieving incisions have been used in the repair of incisional hernia since the beginning of the century. Dixon 1930, described a technique using the medial portion of the incised anterior rectus sheath to reconstruct the linea alba, and then bringing the lateral edges together after making relaxing incisions in the external oblique aponeurosis in overlapping fashion). Several authors described a similar method. In 1992, Loh et al used this anatomical repair, with slight modification.

Technique :

The aim of this repair is to reconstitute the original anatomical structure of the rectus sheath; An elliptical incision over the previous scar is made. Skin flaps are raised to expose the peritoneum over the hernial sac (taking care not to open this if possible) and the anterior lamina of the rectus sheath is identified. Each anterior rectus sheath is then incised longitud-inally, approximately 4 cm laterally from its medial edge. Both aponeurotic flaps are then reflected inward and sutured together with continuous loop nylon. A nylon figure-of-eight darn is then sutured to reinforce this layer; this is therefore converted into the "posterior" layer of the rectus sheath. The lateral edges are thus brought to within 2-3 cm of each other and are sutured together, once again using a continuous loop; this now constitutes the "anterior" layer of the rectus sheath. The skin is then closed after meticulous hemostasis with a suction drain inserted into the sub-cutaneous space.

b. Maingot's Keel Operation.

The term "keel" is applied to this operation because of the wide inversion of the sac and aponeurosis of the rectus muscles, the finished effect in some respects resembles the keel of a ship. The essential points in the technique of the keel operation may be briefly outlined as follows:

1. Wide excision of skin and all scar tissue overlying the hernial sac in order to avoid any ridges or redundancy of skin after the edges of the wound have been sutured.
2. Extensive mobilization of skin and subcutaneous tissues well beyond the margins of the fibroaponeurotic ring. A wide expanse of healthy aponeurosis must be displayed below, above, and on each side of the neck of the sac. The ease with which the margins of the aponeurosis can be approximated before the final closure is, in large measure, dependent on the extent of the freeing of the skin flaps from the healthy and unscarred abdominal muscles.
3. Removal of fibrofatty tissues at the margins of the ring and over the hernial sac itself in order to facilitate the insertion of the sutures and to encourage firm fibrous union.
4. Avoidance of buttonholing or opening the peritoneal sac when the superfluous skin and scar tissue are being excised. The peritoneal cavity should not be opened during the dissection.
5. Use of floss silk, floss nylon or N^{o}1 monofilament nylon for uniting and inverting the fibroaponeurotic margins of the defect.
6. Complete hemostasis and meticulous asepsis.
7. A longitudinal incision through each anterior rectus sheath about 10 cm lateral to the fibroaponeurotic margins to aid relaxation during approximation

of the fibrous ring.

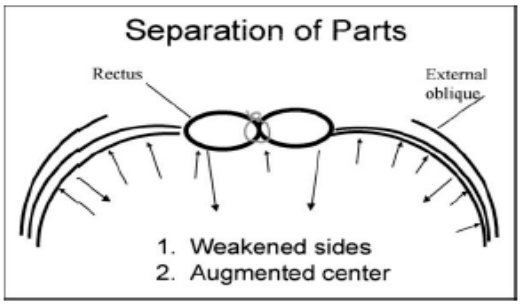
8. Two Redi-Vac polyethylene tubes are placed longitudinally under each skin flap and to the exterior. These are connected with a vaccum suction drainage apparatus. Which rapidly and efficiently removes any collection of blood or serum in the "dead" subcutaneous spaces.
9. Pleating and inversion of the peritoneal sac is no longer done. Now, after the sac is firmly depressed and the fibroaponeurotic margin clearly defined in its entirety, the rectus fascia is sutured together with a series of closely applied mattress sutures. It should be noted that the sutures, when tied, have their knots hidden from view.

When all these mattress sutures have been inserted, the continuous right-angled Cushing stitch is introduced. It is passed through the healthy aponeurosis at the bottom end of the gap and firmly tied, thereby leaving only two knots visible, one at the top and one at the bottom. As previously stated, in many instances it is advisable to make judicious longitudinal relaxing incisions in the anterior rectus muscle sheaths to relieve tension on the suture line. This method is based on the observation that the strong posterior sheath in the upper abdomen reduces the potential for hernia formation in the area of the relaxing incisions. The Keel procedure, is especially useful for large upper midline hernias. Because the keel operation is an extraperitoneal procedure, postoperative distention does not occur, early mobilization is in order, and convalescence is rapid.

4) Nuttall's Operation

Nuttall's operation for midline subumbilical incisional hernia may be used, especially when there is a large defect present immediately above the symphysis pubis. The hernia frequently follows a subumbilical median or a paramedian incision for some gynecologic operations, e.g., hysterectomy. The neck of the sac may be large or ring-like, one portion commonly formed by the symphysis pubis itself.

5) Components Separation of Anterior Abdominal Wall Muscles



Schematic diagram of the abdominal forces after separation of parts hernia repair. Lateral abdominal wall strength is decreased and the rectus muscles are brought to the midline.

In 1990, Ramirez and colleagues performed an anatomical and clinical study in order to determine if the separation of the muscle components of the abdominal wall would allow mobilization of each unit over a greater distance than possible by mobilization of the entire abdominal wall as a block and also to determine whether this method could provide a stable and dynamic abdominal wall support. The anatomical considerations learned from their dissections were found to be applicable to a wide variety of clinical cases. In their technique, Ramirez et al, took the advantage of the presence of three distinct muscle layers lateral to the rectus muscles, in order to facilitate the coaptation of the linea alba. Because the different orientation of the muscle fibers of each one of the components and their complex attachements make it difficult to advance all en block in a given direction, it is necessary to separate the components, mainly the external oblique

from the internal oblique and the rectus from its posterior sheath. The neuro-vascular plane between the internal oblique and transversus abdominis was left intact. Gaps of up to 10 cm in their transverse diameter were closed using this method.

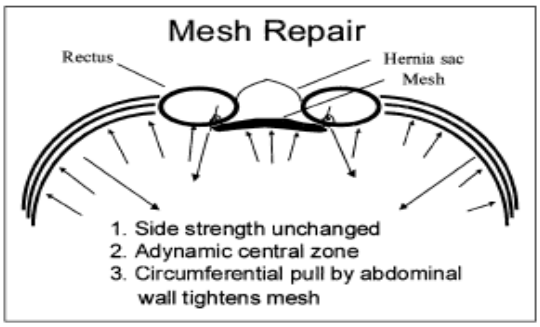
In 1993, Thomas et al continued, utilizing the same principle. In their study, a semiquantitative analysis was performed on the degree of fascial translation (stretch), achieved through the technique of fascial partition. Their technique was as follows. The scar is excised along with redundant skin and peritoneum (hernia sac). Bilateral para-sagittal incisions of the external oblique aponeurosis is performed transcutaneously or after undermining the subcutaneous tissue. Bilateral parasagittal incisions of the transversus abdominis fascia is made transperitoneally. Coaptation of the wound was achieved with multiple interrupted simple sutures of 0 Nylon at the linea alba, 00 Polyglactin 910 at the subcutaneous level and stainless steel staples at the level of the skin. In cases where an absolutely tensionless repair could not be achieved, fascial coaptation followed by application of a reinforcing layer of synthetic material (external to abdominal fascia) may prevent recurrence.

Recently, in 1996, DiBello and Moore reported a four year experience using a modification of the components separation of the myofascial layers of the abdominal wall. The repair is based on a compound flap of the rectus abdominus muscle with its attached internal oblique-transversus abdominus muscle unit and advancement to the midline to recreate the linea alba. In their study, they were able to repair defects as large as 25x 35 cm utilizing this *"sliding myofascial flap of the rectus abdominis".* Once the hernia defect is defined back to viable musculofascia, the abdominal skin is elevated at the level of the deep fascia superiorly to the costal margin, inferiorly to the pubis and laterally to the iliac crests. The repair consists of three steps. In step 1, bilateral parasagittal incisions of the external oblique are made 2 cm lateral to the semilunar line, extending from the costal margin to the inguinal ligament. In step 2, the external oblique is dissected off of the underlying internal oblique muscle the length of the incision and posterolaterally to the lumbodorsal fascia. The internal oblique-transversus abdominus layer is undisturbed, because the neurovascular supply to the rectus and the cutaneous sensory nerves of the lower abdominal wall travel with in this layer. In step 3, the rectus muscles, with their attached internal oblique-transversus muscle units, are brought into coaptation at the midline to recreate the linea alba. It was not found necessary to dissect the rectus abdominis from its posterior sheath or to make any relaxing incisions other than those described. Coaptation of the rectus muscles was performed with a looped 0-nylon suture, in a running fashion. Attenuated repairs were reinforced by a polytetraflouroethylene patch or Vicryl mesh overlay, external to the abdominal fascia, and is anchored laterally beyond the semilunar line for the length of the repair (or just beyond the area of attenuation). Subcutaneous suction drainage was used in all patients, and antibiotics were continued until the drains were removed. All patients were instructed to avoid strenuous exercise as well as heavy lifting for a minimum of eight weeks. A completely tensionless repair, however, is not always achieved using this repair as evidenced by the use of a mesh overlay in two of the seven patients in the study performed by Thomas et al in 1993. DiBello and Moore also used a prosthetic overlay in 43% of their patients in which repairs were attenuated upon coaptation of the rectus myofascial units.

Two additional caveats are relevant. First, the technique of fascial partition /

release is not a panacea. For patients with stomas or catheters traversing the abdominal wall, patients with multiple previously created abdominal incisions or scars, and patients who have required wide radical debridement of the abdominal wall, this technique may not be feasible. Second the clinical experience reported herein is modest and brief. Only additional but justifiable, application of its use and post operative evaluation for a protracted period will establish or refute its merit for treatment of this morbid clinical entity. Nevertheless, preliminary experience suggests that the technique of fascial partition / release should be part of the armamentarium of all herniotomists.

6)Prosthetics Used in Repair of Incisional Hernias



Schematic diagram of the abdominal forces after mesh hernia repair. Lateral abdominal strength is unchanged. Mesh is shown sewn to the undersurface of the rectus abdominis muscle.

The use of reinforcing materials to strengthen a weakened abdominal wall is a comparatively recent development that was initiated during the present century. Surgeons searched diligently for a material to implant into the abdominal wall, something that would add strength while avoiding the excessive tension created while large defects, were bridged, by approximating the patient's own tissues. The era of prosthetic material was initiated in the 1940's when the use of steel mesh was first advocated for the repair of incisional hernias. These inflexible materials were difficult to use and resulted in considerable complications, including persistent sinus drainage, seroma formation and fractured material with loss of tensile strength. The introduction of plastic prosthetics in 1958 rendered metallic meshes obsolete. In 1963, Usher introduced knitted monofilament polypropylene (Marlex) mesh into clinical practice. Since that time, a number of other synthetic materials have been utilized for the repair of large incisional hernias. Each of these materials have unique characteristics that have appealed to surgeons. In 1980, Ponka stated that the ideal prosthetic material has not yet been produced. However, desirable qualities in an ideal prosthetic material would be strength, durability, tissue tolerance, flexibility, ease of handling, non-wandering, tolerance in the presence of infection, availability, porosity, ease of sterilization, non-allerginicity, does not undergo alterations when incorporated with tissue (e.g. cyst formation, malignant changes) and economy. Later, it was found that the ideal biosynthetic material for hernia repair should combine four essential characteristics, namely: that it should be inert; be monofilamented (highly resistant to infection) and contain no pores less than 10 μm in diameter; should stimulate fibroplasia (the growth of fibroblasts through the interstices of the mesh, thus permitting a strong layer of collagen deposition) and be rapidly fixed in place by the host's fibrin glue. It should also retain a high intrinsic tensile strength.

Classification of Reinforcing Materials Used in Incisional Hernia Repairs

No single classification if implantable material is completely satisfactory. A variety of tissues, metallic substances,

and synthetic materials have been used to replace tissues whenever deficient. In some instances the patient's own tissues were shifted or relocated as free grafts and, hence, cannot be considered prosthetic materials even though they do provide reinforcement of weakened abdominal wall areas. The following list is of several materials that have been used, or are currently employed, in the repair of abdominal wall defects (namely, incisional hernias).

I. Autografts
- **A**. Fascia Lata
  1. Free
  2. Pedicle
- **B**. Cutis Grafts
- **C**. Whole Skin

II. Homografts
- **A**. Fascia Lata
- **B**. Aorta

III. Heterografts
- **A**. Fascia
- **B**. Pericardium

IV. Metallic
- **A**. Stainless Steel
- **B**. Tantalum
- **C**. Silver

V. Synthetic - Plastic
- **A**. knitted / woven Polypropylene (Marlex / Prolene)
- **B**. Mersilene (dacron polyester)
- **C**. Nylon (polyamide)
- **D**.Others
  1.Expanded Polytetraflouroethylene
  2.Ivalon Sponge (formalized polyvinyl)
  3.Molded Polyglactin 910 (Vicryl)

Autogenous Fascia Lata Graft

It was Askar (1984) who first advocated the use of autogenous fascia lata strips to darn aponeurotic hernial defects of more than one inch in diameter. Strips of fascia lata 3 to 4 cm in breadth were used to fashion an interwoven mesh, the strips were obliquely placed so as to be in line with the tendinous fibers in the aponeuroses of the anterior rectus sheaths. Fascia lata grafts could be used in incisional hernias in which the ring or separation of the wall is so large that no suture method could adequately close the opening. These grafts have the advantage of being derived from the patient, hence, there will be no tissue reaction. Its width prevents it from cutting through tissues. It will also survive in the patient retaining its strength for prolonged periods of time. However, the need for a second operative procedure is inconvenient to both patient and surgeon. The potential for the development of seroma or haematoma at the donor site due to extensive dissection, coupled by the residual long scar left over in the thigh are disadvantages.

Skin and Cutis Grafts

Cutis grafts consist of skin minus the epidermal covering that can be removed by scraping, shaving or cutting it off with a dermatome. Indications for use of such grafts are if the repair cannot be done without tension, if the abdominal wall was weak and flabby and the patient was obese, in recurrent incisional hernias or if the hernial sac was lobulated with multiple defects, or if the patient was a young or middle aged female with the possibility of pregnancy in the future. However, if the covering skin was unhealthy (predisposing to infection, since the skin used for the graft is that overlying the hernial sac) or if the hernia was strangulated (prolonged operative time and potential for wound contamination), skin grafts are contraindicated. Because of the danger of infection, sinus formation, epidermoid cyst formation and even carcinomatous changes, in addition to the easy availability of effective synthetic prosthetic materials

or fascia lata, the use of skin or cutis grafts in hernia repair is generally not advised.

Stainless steel mesh

One hundred and fifty large abdominal incisional hernias were treated following a standardized operating technique using stainless steel mesh and approximation of the anterior rectus sheath. The average follow up was four years. Good results without pain were found in more than 95 percent of the patients. Recurrence occurred in 9.5% of the patients. Stainless steel mesh proved to be an excellent prosthesis in keeping with numerous experimental studies. It is of special interest because of its remarkable resistance to infection, but the metal mesh has been criticized as a source of pain and for being poorly tolerated when in contact with viscera. Strict haemostasis, gentleness, avoidance of undue trauma, and the use of sharp dissection are identified as important technical details. The rate of infection when using the mesh is reported to be 0.1%, and even then, it is not necessary to remove the mesh in any patient. However, there is some prejudice against the material because it is a metal. There is also the fear that the material will fragment, migrate and cause pain.

Mersilene mesh

It is a synthetic mesh of polyester fibers. It has favorable properties, as it is readily available, inexpensive, soft, pliable, relatively inert, well tolerated by tissues, maintains a good tensile strength and does not unravel at cut edge. It is an effective material than can be used with safety with complication and recurrence rate of only 1%. The need for adequate dissection, careful hemostasis and asepsis can't be over emphasized. However, Mersilene is not monofilamented and does not stimulate intense fibroplasia through its interstices.

Nylon

Nylon initially gained acceptance among surgeons through its use as a strong and durable suture material that caused minimal tissue reaction. On the other hand, nylon tends to lose its tensile strength and to fall apart when used as an implant; furthermore, it loses 80% of its strength due to hydrolysis and chemical deterioration. At present, nylon cannot be recommended as a desirable prosthetic material for repair of abdominal wall defects.

Molded polyglactin mesh

Utilization of absorbable molded polyglactin mesh to repair abdominal wall yielded that:

1- At three weeks, the mesh present was associated with intense foreign body reaction with numerous histiocytes.
2- At 12 weeks, no mesh was present but some striated muscle proliferation from the resected ends was evident. No prominent elastin or collagen deposition occurred at the site of abdominal wall excision.
3-Polyglactin mesh maintained satisfactory integrity at 3 weeks for it to be considered as a temporary fascial substitute in patients with abdominal wall defects associated with severe infection.
4- Polyglactin mesh may be suitable as a short term substitute, but it does not allow enough fibrous tissue formation before hydrolysis to render it utilizable as a permanent abdominal wall support.

Polypropylene Mesh

Knitted polypropylene (Marlex) mesh or weave-knit Prolene mesh is incorporated in the body and has a molecular structure that resists bacterial entrapment. Its tensile strength is retained indefinitely. It is soft, pliable and easy to work. It can be safely autoclaved and may be trimmed in the operating room with scissors, without fear of unraveling. It resists infection, is

not extruded and granulation tissue grows over and through it. Experience with the material over many years revealed it to be the only one to fulfill the criteria desirable for a prosthesis (inert, monofilamented with pores larger than 10 μm in diameter, stimulates fibroplasia and rapidly fixed in place). Indeed, fibrous infiltration within the mesh is very rapid that it frequently is impossible to remove the patch or even to identify it after several weeks have passed. However, there remains a growing concern for its use with incisional hernias because of the possibility of intra-abdominal adhesions and subsequent intestinal fistula formation. At the present time, all available synthetic meshes are plagued by this problem

Expanded-Polytetraflouroethylene Patch

Another prosthetic material used and is gaining increasing popularity due to its low tissue reactivity, is expanded polytetraflouroethylene (ePTFE). This material results in less adhesion to underlying bowel than does Marlex mesh. This is presumably because of the lesser fibrous in growth into the small interfibrillar spaces of the PTFE material. Although this is a desirable feature of PTFE, the lack of fibrous ingrowth makes the repair more reliant on the inherent tensile strength of the material and the integrity of the suture attachment of the prosthetic to the fascia. With its internodal architecture, the patch contains an infinite number of pore sizes and presents innumerable crevices in which bacteria can hide and proliferate. Moreover, although the material can be invaded by bacteria, neutrophils are unable to reach the offending organism, thus diminishing the body's defenses against infection. A further disadvantage is its costly price.

Indications for using prostheses in the repair of incisional hernias:

1-Recurrence following incisional hernia repair.
2-Presence of large defect with loss of substance of the abdominal wall.
3-Obesity.
4-Pulmonary diseases such as severe emphysema chronic bronchitis and severe cough.
5-Patients who perform heavy work as weight lifters.
6-Patient on prolonged steroid therapy as the liability for recurrence is high.
7-Irradiation as it reduces healing of wounds and causes atrophy of the tissues due to impairment of blood supply.

Technique of prostheses placement:

Any prosthesis when used in repair of abdominal defects can be located in between any two layers of abdominal wall and it may be:

1- Intraperitoneal.
2- Preperitoneal.
3- Subaponeurotic.
4- Subcutaneous.

The mesh may be implanted in two layers, or it may serve to bridge a defect in the abdominal wall. During the past 50 years, surgeons have gained much useful information regarding the use of prosthetic implants as a means of adding strength to a more or less compromised abdominal wall. It has been recognized that excessive tension produced by injudicious attempts at closure of all hernias without implants results in an unacceptably high number of recurrences. Surgeons have accepted the premise that prosthetic implants do, in fact, increase the strength of repair. Many operative techniques with prosthetic materials have been described on the basis of the anatomic positioning of the prosthesis.

Massive Incisional Hernia Repair with Marlex)

Excess skin, the hernial sac, old sutures, scarred muscle and aponeurosis are first excised elliptically with careful hemostasis. Cautery is employed rather than leaving ties in the subcutaneous tissue. Excision should extend above and below the old incision so as to encounter normal body wall circumferentially. Subcutaneous tissue is cleaned back from the underlying fascia for 5 cm on all sides to allow for individual placement of mattress sutures before tying. Similarly, the peritoneal surface has to be rid of adhesions for an equivalent distance to allow for mass suturing through the entire abdominal wall. An effort to lyse the bowel so as reduce the risk of postoperative bowel obstruction should be made. Marlex or Prolene, when stretched smooth and maintained that way, have a tendency to adhere and erode bowel. Fistula or obstruction with abscess or peritonitis may ensue. To avoid this serious hazard every effort should be made not to have the prosthesis lie directly on the intestines. Usually, omentum, peritoneum, or hernial sac can be interposed. If this is not possible, a double layer of polyglycolic acid mesh is placed as a sandwich. Marginal recurrence, from the prosthesis tearing out from the edges of the wound, is the main mechanism of failure. To avoid this, significant overlap with normal tissue is important; sutures with pledgets or parallel bolster strips sutured down to the abdominal wall are used. The prosthesis can be folded to envelop the superficial and deep surface of the margin. If the defect is large then two such patterns can then be joined in the middle with Prolene suture. The Prolene mesh is cut to produce enough tension to eliminate bulges, folds, or creases, which can act as a foreign bodies damaging tissues and inducing inflammation and seromas, the prelude to infection. Since monofilament sutures are now available, wire is obsolete because it cuts both the patient's and surgeon's tissues. It is also difficult to work with because of kinking. Vertical mattress sutures tied with five knots are employed rather than horizontal sutures so as to preserve the blood supply to the wound edges. Each placement is made by successive "halving". They are tagged and then tied all at once. Individual placement in this manner allows for relaxation and a proper assessment of the tension in the prosthesis.

The Stoppa Technique

Stoppa, in 1989, described a technique of placement of a large sheet of mesh buried deeply in the extraperitoneal (retro-parietal) separable space. He used Mersilene mesh for his repair. The aim of his repair was face-to-face adhesion of the prosthesis to the parietal layer and not edge to edge patching. Thus the mesh would not lie in direct contact with viscera, preventing visceral adhesion to the mesh. The prosthesis extending well beyond the parietal defect, is maintained by peripheral sutures transfixing the abdominal wall and tightened through cutaneous button-holes, which are sutured closed. He used suction drainage postoperatively with the drains placed in contact with the prosthesis. Results of his technique were 85.5% success after five years, he advised experienced surgeons to use retro-muscular prostheses to repair not only large but all incisional hernias. Attracted to the mechanics of this technique (tension-free method, large surface area of mesh for tissue incorporation and the posterior patching of the defect), a modification of this technique, the Rives-Stopa-Wantz, is currently the most popular repair for incisional hernia in practice.

Operative Technique

The modified Stoppa technique involves placing a very large sheet of

polypropylene mesh in the plane anterior to the posterior rectus fascia (or inferior to the semicircular line and anterior to the peritoneum) but posterior to the rectus muscle. For most ventral hernias the skin incision is best placed directly over the hernia defect. Because the mesh will patch the defect between the medial edges of the posterior rectus fascia in a tension-free manner, the entire peritoneal sac should be preserved to serve as a barrier (of autogenous tissue) between the posterior surface of the mesh and the intraperitoneal contents. Although every attempt is made to remain extraperitoneal throughout the repair, occasionally the peritoneal cavity may be entered inadvertently while freeing the peritoneal sac in the subcutaneous space, or a concomitant intraperitoneal procedure is performed at the time of hernia repair. Under these circumstances the peritoneal defect can be closed by sutures or buttressed from behind with the omentum or both in attempts to keep autogenous tissue between the posterior surface of the mesh and the underlying bowel to prevent adherence and the risk of fistula. Once the hernia sac has been reduced, the plane for eventual placement of the mesh is best entered by palpating the medial edge of the rectus muscle, making an anterior fasciotomy through the anterior rectus fascia, exposing the medial edge of the rectus muscle, and then bluntly developing the space out laterally at least to the midclavicular line or even further laterally between external and internal oblique muscles to the anterior axillary line. The rostral and caudal extent of the dissection should extend 4 - 6 cm rostral and caudal to the hernia defect; one should carefully evaluate the entire length of the incisional hernias for other Swiss cheese-like defects that may not have been evident before operation. At the xiphoid and costal margins the plane behind the rectus muscle extends above the xiphoid and costal margins, allowing fixation of the mesh above each of these structures. The mesh should extend quite far laterally (between midclavicular and axillary line) attempting to maximize the surface area for tissue incorporation into, and fixation of the mesh. To fix the mesh in place laterally, instead of mobilizing the subcutaneous space out laterally, individual stab wounds in the skin are made at the lateral extent of the mesh, a long needle with a 0-absorbable or nonabsorbable suture material (polydioxanone or polypropylene) is then passed through the stab wound, through the external oblique or rectus fascia, through the abdominal wall musculature into the plane containing the mesh, through the mesh in mattress fashion, then back through the abdominal wall musculature and the external fascia, and finally through the stab wound. When the two ends of the suture are tied, the knot lies in the subcutaneous space anterior to the external fascia. After the mesh is sutured in place, an attempt is made to close the anterior rectus fascia over the mesh, even if it requires external tension at the suture. However, this maneuver is usually not possible in large hernias. Suction drainage is used and the patient is given perioperative antibiotics. The authors preferred to use polypropylene mesh, not only for cost reasons but also because of the superior tissue ingrowth that occurs compared with some of the other prosthetic materials. However, ePTFE patch was used when no autogenous tissue was available to place between the posterior surface of the mesh and bowel to lower the risk of fistula formation

The Starburst Mesh Closure Technique

Marginal recurrence (at the edge of mesh) is reported to be the major type of recurrence after mesh repair of incisional hernia. Technical errors of inadequate fixation of the periphery of the mesh, fixation to weak fascia and lack of adequate overlap between mesh and

fascia are reported to be the main causes of such recurrence. On basis of such findings, Young et al (1994) devised a method of mesh repair believed to distribute the abdominal forces towards the center of the mesh, thus decreasing the amount of force applied to the fascial edge and hence marginal recurrence.

Operative Technique

The skin is incised longitudinally, and the peritoneal cavity entered. Adhesions to the sac are lysed and a free plane created extending 10 cm from the fascial edge. A piece of Marlex mesh is fashioned to the shape of the defect with 2 x 10 cm spokes radiating from the central area of the mesh. The mesh is applied and the spokes brought out from beneath the fascia 7.5 cm from the fascial edge. The central area of the mesh is then sutured to the fascial edge with a running Prolene suture. Each point where the spokes exited the fascia is secured with a single Prolene suture. The ends of the spokes are then brought over and sutured toward the center of the mesh. No drains are used. Redundant skin is excised and the remaining skin is then closed in the usual fashion.

Use of Omentum in Mesh Repair of Incisional Hernias

The use of plastic mesh for the repair of incisional hernias may lead to the formation of adhesions and fistulas when this mesh is in direct contact with abdominal viscera. It has been suggested that covering the internal aspect of a non-absorbable mesh with an absorbable one may prevent adhesions and avoid intestinal fistula formation. However, evidence show that currently available absorbable and non-absorbable materials do adhere to the subjacent intestine, and that adhesions do occur to the remaining permanent mesh after disappearance of the absorbable one. Prosthesis implantation could extend beyond the borders of the defect, above the peritoneum or the posterior rectus sheath, using abdominal pressure to help fix the mesh to the musculoaponeurotic plane. The dissection of these planes may be difficult, or tension free closure may not be possible in large or multi-operated midline hernias. In these cases omentum is used to prevent contact of the mesh with the viscera.

Operative Technique

In midline supraumbilical hernias, when the peritoneum or posterior rectus sheath, if the former is not available, cannot be totally closed without tension, an omentoplasty is performed suturing the omentum with interrupted sutures (2/0 Vicryl®) to the edges of the remaining defect. In patients with infra-umbilical midline hernias, the peritoneum may be extensively destroyed or difficult to dissect from the musculo-aponeurotic plane. In these cases, as the posterior rectus sheath is not present at this level, an omentoplasty is performed. Superiorly, the posterior rectus sheath is dissected above the line of Douglas and closed down to this level (0-Prolene®) and the omentum sutured to the line of Douglas (2/0 Vicryl®). Inferiorly, at the symphysis pubis, the prevesical space and laterally the retroinguinal spaces are dissected in order to extend the mesh beyond the pubis. The inferior edge of the omentum is then sutured to the superior edge of the pelvic peritoneum. Laterally the omentum is fixed to the posterior aspect of the abdominal wall beyond the lateral border of the rectus.

Incisional Hernia Repair With Simultaneous Panniculectomy

The repair of incisional hernias in obese patients presents an interesting clinical challenge. It is of historical interest that the first panniculectomies of the abdominal wall was performed by surgeons to gain access for umbilical

hernia repair (Hughes et al, 1996). Hughes and colleagues (1996) described a technique of simultaneous panniculectomy at the time of incisional herniorraphy not only as a means to provide access to the hernia, but also to prevent hernia recurrence. Better visualization and exposure allow a more secure repair. They believed resection of excess abdominal fat decreases abdominal strain, which contributes to recurrence when lifting, sitting up, coughing, exercising, etc..

Surgical Technique:

Patients are evaluated as medically indicated pre-operatively to assess potential cardiac and pulmonary risks. Deep venous thrombosis prophylaxis using either plastic stockings or sequential compression devices is employed in high risk patients. Preoperative markings are used to identify surgical incision lines. In all cases, a standard lenticular incision is used. The pannus is removed from the surgical field, and repair of the hernia is begun. Herniorraphy is accomplished by simple approximation using absorbable (Vicryl®, PDS/Ethicon, Somerville, NJ) or permanent (Prolene/ Ethicon, Somerville, NJ) sutures after hernia sac excision. In many cases, this repair is reinforced by imbricating the anterior rectus sheath on either side using figure-of-eight sutures of 2-0 Prolene®. Marlex® mesh is used as an onlay patch technique for increased strength where fascia was weak. The umbilicus is excised with all panniculotomy specimens. The upper abdominal apron is then advanced over closed suction system drains to the lower margin of resection above the pubis. In all cases, at least two drains, but never more than four, are used. The flaps are closed using inverted interrupted 2-0 Vicryl® as a buried suture and a running subcuticular stitch of 3-0 or 4-0 Vicryl®. Patients receive preoperative antibiotics. A first generation cephalosporin is used in the majority of cases.

7) Laparoscopic Repair

Until now, the laparoscopic repair of incisional hernias has proven difficult in terms of obtaining adequate tension of the patch, complete covering of the hernial defect and secure stapling. Thus, Tagaya et al (1995), devised a new surgical technique of laparoscopically fixing an ePTFE on the anterior abdominal wall. The four corner tacking technique can prevent an ePTFE patch from sliding out of position on the anterior abdominal wall during fixation.

Operative Technique

Following the creation of a pneumoperitoneum under general anesthesia, the hernia is repaired using a 1mm thick e-PTFE patch, 5x10 cm or 10x15 cm in size, inserted intraperitoneally. Before the patch is inserted into the peritoneal cavity, its proper positioning on the inside of the abdominal wall is ensured. Next, the corresponding external boundaries if the patch are marked on the abdominal wall with a surgical pen, making certain that the patch will cover the hernia sac and overlap the margins of the defect by about 2 cm on every side. The patch is then inserted in the peritoneal cavity through the trocar. A 60 mm straight needle, threaded with 80 cm of 2-0 nylon is inserted through the marking point on the anterior abdominal wall into the abdominal cavity. This needle is held by a laparoscopic needle holder from within the abdominal cavity, and one edge of the patch is penetrated using forceps laparoscopically. The needle is again pushed through the abdominal wall from the inside to the outside near the previous marking point, using the laparoscopic needle holder. The suture is tied extra-corporeally on the marking

point of the anterior abdominal wall. All four corners of the patch are tacked to the anterior abdominal wall using the same procedure. Finally, the patch is fixed to the anterior abdominal wall by a laparoscopic stapler. The four nylon sutures are later removed from outside the abdomen.