Repair of complex giant or recurrent ventral hernias by using tension-free intraparietal prosthetic mesh (Stoppa technique): Lessons learned from our initial experience (fifty patients)

Thamrongroj Temudom, MD, Mohammad Siadati, MD, and Michael G. Sarr, MD, Rochester, Minn.

**Background.** Giant complex ventral hernias are difficult to repair, and recurrent rates are high (greater than 10%). Our aim was to review our experience with a modified Stoppa technique.

**Methods.** From 1991 to 1995, 50 patients underwent repair with a large panel of prosthetic mesh placed intraparietally posterior to rectus muscle but anterior to posterior rectus sheath; 27 had undergone one to five previous hernia repairs, and 14 patients had a simultaneous intraabdominal procedure. Mean follow-up (100%) has been 24 months.

**Results.** No operative deaths occurred. Hospital morbidity included four wound infections, 2 of which were serious and required mesh removal; both occurred in patients in whom the gut was opened for other simultaneous intraabdominal procedures. Late morbidity included two delayed wound infections/limited mesh infections managed by office débridement and open packing, three seromas, and transient abdominal wall pain in seven patients. Long-term follow-up showed no recurrent hernias in the 48 patients without early serious mesh infections requiring mesh removal; thus the long-term success rate was 96% (48 of 50 patients).

**Conclusions.** Recurrent rates after this modified Stoppa repair of giant complex giant ventral hernias are very low. Early or late mesh infection occurred in four patients. Tension-free prosthetic mesh repair offers a marked improvement in outcome. Because of the possibility of mesh infection, simultaneous, contaminated, or even clean-contaminated intraperitoneal procedures should be avoided if possible. (Surgery 1996;120:738-44.)

From the Department of Surgery, Mayo Clinic, Rochester, Minn.

**Massive abdominal wall hernias,** whether primary or incisional, are difficult to repair, especially when multiply recurrent or when the defect is so large that primary approximation of the fascial edges is either impossible or would lead to unacceptable tension at the suture line. Many techniques have been developed in an attempt to repair these difficult hernias, including primary autogenous repair incorporating lateral "relaxing" incisions or advancement flaps of rectus fascia, placement of subfascial tissue expanders several weeks to months before operation to "stretch" the rectus fascia, or numerous types of repairs with prosthetic mesh material.

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*Current address: Department of Surgery, Indiana University Medical Center, 545 Barnhill Dr., Indianapolis, IN 46202.

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Recently Stoppa has reported an extensive experience with a mesh repair in which the prosthetic mesh is placed intraparietally in a tension-free manner to patch the hernia from behind rather than on top as with an onlay graft. Because the mechanics of this repair are quite attractive from a theoretic standpoint—tension-free, large surface area of mesh for tissue incorporation, and posterior patching of the defect—we have adopted this approach for large, complex, and/or multiply recurrent ventral hernias for the last four years. This report summarizes our initial experience with 50 consecutive patients and, more importantly, outlines several of the lessons we learned from this initial experience.

**Clinical material**

We reviewed the medical records of our first 50 consecutive patients (all operated on by the senior author [M.G.S.]) who underwent a modified Stoppa technique for complex or massive ventral hernias at Mayo Clinic from 1991 to 1995. We carefully recorded the preoper-
operative conditions, details of surgical management, hospital morbidity, and outcome to date, especially concentrating on infective complications and hernia recurrences. The follow-up data were obtained during return visits and supplemented by written or verbal correspondence with the patients or their primary physicians. Mean follow-up (100%) has been 24 months (range, 2 to 56 months).

Operative technique. The modified Stoppa technique involves placing a very large sheet of polypropylene mesh (Prolene mesh; Ethicon, Inc., Somerville, NJ) 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 (Fig. 1). 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 (lateral edge of the rectus muscle) or even further laterally beneath external and internal oblique muscles to the anterior axillary line.

The rostral and caudal extent of the dissection should extend 4 to 6 cm rostral and caudal to the hernia defect; one should carefully evaluate the entire length of 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 anterior axillary line) in attempt 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 (Figs. 1 and 2).

We have 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, when no autogenous tissue was available to position between the posterior surface of the mesh and the bowel, we have used a sheet of expanded polytetrafluoroethylene (Goretex; W. L. Gore and Associates, Phoenix, AZ) because of the relative lack of tissue ingrowth, formation of a pseudocapsule, and thereby a lower risk of fistula; an additional benefit of polytetrafluoroethylene material is...
that it is watertight and maintains integrity of the peritoneal cavity. This can be beneficial in large exposed peritoneal defects that would weep through the interstices of a polypropylene prosthesis or when there is associated ascites as with a large umbilical hernia in a patient with portal hypertension. Occasionally we use a composite graft of expanded polytetrafluoroethylene medially where the prosthesis would be in direct contact with the bowel and polypropylene laterally where there would be a large intraperitoneal surface of abdominal wall for maximal tissue ingrowth and fixation of the mesh (Fig. 3).

After the mesh is sutured in place and the redundant mesh is excised, an attempt is made to close the anterior rectus fascia over the mesh, even if it requires external tension at the suture line; this is done to place another layer of autogenous tissue between the anterior surface of the mesh and the subcutaneous tissue. This maneuver, however, is usually not possible in these large hernias. One or two closed suction drains are left either in the subcutaneous space anterior to the mesh or in the plane where the mesh lies. These drains are removed as early as possible when drainage decreases below 50 ml/day, generally 2 to 4 days after operation. Patients are
Table I. Simultaneous intraabdominal surgical procedures during modified Stoppa ventral herniorrhaphy

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastric bypass</td>
<td>9</td>
</tr>
<tr>
<td>Left oophorectomy</td>
<td>1</td>
</tr>
<tr>
<td>Tubal ligation</td>
<td>1</td>
</tr>
<tr>
<td>Pelvic exploration</td>
<td>1</td>
</tr>
<tr>
<td>Lysis of adhesion</td>
<td>1</td>
</tr>
<tr>
<td>Take-down colostomy</td>
<td>1</td>
</tr>
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</table>

given perioperative prophylactic antibiotics, usually cefazolin.

RESULTS

Patient population. The 24 men and 26 women had a mean age of 52 years (range, 32 to 77 years). Twenty-seven patients had undergone one to five previous ventral hernia repairs, including 13 patients who had undergone a previous mesh repair with an onlay technique. Twenty-four patients were quite obese (greater than 40% above ideal body weight). Simultaneous intraabdominal surgical procedures were performed in 14 patients (Table I).

Twenty-eight hernias were midline (16 primarily above, 6 below, and 2 both above and below the umbilicus), and four were huge umbilical hernias; 21 were complex hernias involving both a midline or paramedian incision and parts of a subcostal or transverse incision as well. One additional complex hernia involved the entire left upper quadrant from a previous transverse incision. All defects were either large enough (defect larger than 6 cm) that primary repair was either impossible or deemed unwise because of the resultant tension at the suture line or occasionally were multiply recurrent with unacceptable fascia for a primary repair.

Operative (early) morbidity. No operative deaths occurred. Significant perioperative morbidity occurred in seven patients (Table II). Two patients had a wound hematoma managed conservatively, and one patient had a prolonged ileus requiring nasogastric decompression despite a fully extraperitoneal herniorrhaphy. Wound infections occurred in four patients (8%). These infections, albeit minor in two patients, had serious consequences in two patients who required complete mesh removal. In one patient the mesh was removed on postoperative day 3 at which time a small enterotomy was noted in a knuckle of jejunum at a previous transrectus colostomy site; this enterotomy had been inadvertently at the time of herniorrhaphy and had not been noticed. The second patient returned 12 days after operation after repair of a complex, multiply recurrent, huge ventral hernia with three composite panels of

15 × 20 cm expanded polytetrafluoroethylene; this patient also underwent a simultaneous Roux-en-Y gastric bypass for morbid obesity (165 kg). Both these patients had a prolonged hospitalization and required wound closure by secondary intention; both were left with a large ventral hernia, one of which (the former patient) has subsequently been rerepaired successfully by means of a similar technique.

Late morbidity. Except for the two patients who required early removal of the mesh, there have been no recurrences in follow-up at a mean of 24 months (range, 2 to 56 months). Delayed, localized mesh infections eventuating in a chronic, intermittently draining sinus tract to the skin occurred in two patients. One patient had a 1 cm section of nonincorporated mesh removed in the office under local anesthesia with complete resolution; the other has a sinus tract that continues to drain intermittently but is otherwise asymptomatic. Seromas requiring percutaneous aspiration developed in two patients. Seven patients had temporary abdominal wall pain bothersome enough to return for a follow-up visit. This pain was most commonly described as a pulling, tearing sensation, usually in the lowermost aspect of the abdomen at the lateral extent of the mesh in the area of suture fixation.

Most patients returned to work or gainful employment within 4 to 8 weeks. Subjective satisfaction has been high (94%), but the outcome in the two patients with serious wound infections requiring early mesh removal was unsatisfactory.

DISCUSSION

Complex, giant, and recurrent ventral hernias are notoriously difficult to repair and are associated with a high recurrence rate. Our approach using a modified Stoppa technique, in which a large sheet of polypropylene mesh was placed intraparietally within the abdominal wall, was associated with excellent results. Patients were generally quite pleased with the results. However, two serious mesh infections required mesh removal. At a mean follow-up of 24 months we noted no recurrences.

Table II. Complications of modified Stoppa ventral herniorrhaphy

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early morbidity (&lt;30 days)</td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>4*</td>
</tr>
<tr>
<td>Wound hematoma</td>
<td>2</td>
</tr>
<tr>
<td>Ileus</td>
<td>1</td>
</tr>
<tr>
<td>Late morbidity</td>
<td></td>
</tr>
<tr>
<td>Localized mesh infection</td>
<td>2</td>
</tr>
<tr>
<td>Wound seroma</td>
<td>3</td>
</tr>
<tr>
<td>Temporary abdominal wall pain</td>
<td>7</td>
</tr>
</tbody>
</table>

*Two required complete mesh removal at 3 and 18 days after operation.
Incisional hernia represents one potential element of morbidity after abdominal surgery. Its incidence is somewhere between 2% and 11% depending in large part on the characteristics of the patient population. Although repair of small uncomplicated incisional hernias with primary reapproximation of the fascial edges has excellent results, the repair of large incisional hernias by excision of the sac back to healthy fascia and primary closure, with or without lateral fascial relaxing incisions, is associated with recurrence rates approaching 30%; this recurrence rate increases to 44% for similar repair of recurrent incisional hernias. Modifications of autogenous tissue repairs for these large hernias, such as the internal retention repair or local anterior rectus sheath medial rotation flaps, have been described, but persistent tension at the suture line is often unavoidable. Moreover, these repairs use local tissue, which itself may express metabolic abnormalities in collagen synthesis.

The introduction of repairs with nonabsorbable prosthetic materials, such as polypropylene mesh (Prolene or Marlex; Ethicon, Inc., Somerville, NJ, and Bard Vascular Systems, Billerica, MA, respectively) or expanded polytetrafluoroethylene, have decreased the recurrence rates significantly to the 6% to 10% range in several reported series. Many operative techniques with prosthetic material have been described on the basis of the anatomic positioning of the prosthesis, including prefascial positioning (onlay technique), intraperitoneal positioning, and intraparietal placement, such as the Stoppa technique. The onlay technique requires less dissection because the prosthesis is placed anterior to the abdominal wall fascia; however, in theory the intraabdominal pressure is transferred to the edges of the mesh at the lateral aspect of the defect, and recurrences tend to occur in these regions laterally.

Intraparietal placement has the disadvantage of direct apposition of the prosthesis with intraperitoneal structures such as the bowel; adherence and possible erosion of the bowel wall may result in sepsis, fistula, or bowel obstruction. The Stoppa technique is an attractive alternative because it offers many theoretical advantages. First, by preserving the hernia sac, a layer of viable autogenous tissue persists to serve as a barrier between the prosthesis patching the defect and the intraperitoneal contents. Second, intraparietal placement of the prosthesis allows well vascularized anterior soft tissue coverage of all aspects of the prosthesis, except the area patching the defect, which consists of skin and subcutaneous fat. Third, use of such a large sheet of porous mesh (polypropylene) allows a very large surface area laterally for ingrowth of connective tissue from the well vascularized rectus muscle, which leads to permanent fixation of the prosthesis within the abdominal wall. Fourth, the wide lateral intraparietal placement anterior to the posterior rectus sheath avoids the possibility of recurrent hernias occurring at the lateral edge of the hernia defect; indeed, unlike the external onlay repair in which intraabdominal pressure tends to push off the prosthesis, with this Stoppa technique intraabdominal pressure tends to hold the mesh in place apposed to the posterior rectus muscle over a wide surface area. Finally, this is a tension-free repair that patches the defect rather than attempting to close the defect by reapproximating the fascia edges under tension.

The major disadvantage of all repairs with prosthetic material is the risk of infection. Surgeons have generally been reluctant to implant heterogeneous material for fear of infective complications. General perceptions have been that repair of an incisional hernia is considered to be a clean surgical procedure, and use of prosthetic material is associated with higher infection rate. However, some reports suggest that repair of incisional hernia in itself has a significantly higher rate of infection than do other clean general surgical procedures, and the use of mesh is not necessarily related to a higher incidence of wound infection (5.5% with mesh versus 6% without mesh). On the basis of these data the infection rate of this subset of hernias would be higher by virtue of their complexity whether synthetic material was used or not.

Nevertheless, the incidence of mesh infection in this series was 8% (4 of 50 patients), similar to that reported by Stoppa. Two of these patients had a deep space wound infection early after operation, requiring complete removal of the mesh. This complication was associated with significant wound morbidity requiring a long interval of wound closure by second intention and, of course, a persistent hernia. Two other patients had a probable late but localized mesh infection managed by office débridement; morbidity has been minimal in these patients. All four patients with mesh infections had the bowel opened, three as part of a simultaneous intraperitoneal procedure and the other inadvertently, which was not recognized at the time. Thus all of these mesh infections were potentially avoidable. On the basis of these observations, our current recommendation is the following: if an intraabdominal procedure is being performed in which the gut is opened or a source of sepsis is found during repair of a large, complex, or recurrent ventral hernia that would otherwise require repair with prosthetic material, strong consideration should be given to postponing definitive repair of the hernia with a permanent, nonabsorbable prosthetic material to a later date as a separate operative procedure. We also advocate routine prophylactic perioperative antibiotics with good coverage of Staphylococcus species.
The choice of the optimal prosthetic material remains unknown. We prefer polypropylene mesh because of the complete tissue ingrowth and resultant fixation within the abdominal wall when compared with the microscopic ingrowth of expanded polytetrafluoroethylene. In contrast, when the prosthetic material must be in contact with the bowel, for instance when the hernia sac cannot be preserved and there is insufficient omentum to serve as an autogenous tissue barrier, then expanded polytetrafluoroethylene may be a more appropriate material for the same reasons.

Our results compare favorably with previous reported experience. Stoppa described his experience with 466 incisional hernias, 79% of which were repaired with prosthetic material. Mortality was 1.8%, wound hematoma occurred in 3.2%, and wound sepsis complicated 12% of procedures. None of the mesh infections required mesh removal; however, long-term morbidity in these patients with mesh infection was not well described. Overall results at 5.5 years after operation showed an 86% rate of good results compared with a 48% success in the patients who had a nonmesh herniorrhaphy. Similar results were reported by two other groups. Another group reported no recurrences, wound infections, or gastrointestinal complications in 54 patients with large defects (greater than 10 cm).

One further point warrants acknowledgement. Abdominal wall pain is not an uncommon complaint, even for up to 3 to 6 mo after operation. This occurred in 7 of 50 patients in our initial experience. Most patients described an ill-defined pulling or tearing discomfort during movement that was localized usually to the lower abdomen at the lateral edges of the mesh where it was fixed to the abdominal wall. While annoying enough to return to the surgeon for examination (and thus not insignificant), it was not severe enough to warrant intervention and eventually disappeared.

In summary, this modified Stoppa technique for repair of large, complex, and recurrent ventral hernias had excellent functional results with no recurrent hernias noted at mean follow-up of 2 years. Because mesh infection occurred only in those patients who underwent a simultaneous intraperitoneal procedure in which the gut was opened, strong consideration should be given to postponing this type of definitive ventral herniorrhaphy when intraperitoneal gut surgery is also required.

REFERENCES


DISCUSSION

Dr. Gerald Larson (Louisville, KY). You are to be complimented for your very good results and very low recurrence rate of 4%. You have demonstrated and validated four principles of repair of complex and recurrent ventral hernias, which I would like to emphasize. First, the repair should be tension free. Second, a generous piece of mesh should be used that is much larger than the defect to allow for healthy tissue ingrowth and incorporation. Third, the mesh should be anchored into very solid and healthy musculofascial tissue around the periphery. The subsequent repair will be only as strong as the tissue to which the mesh is anchored. Fourth, you have demonstrated that a posterior repair, in this case posterior to the rectus muscle, is superior to the onlay technique, which had been used in 13 of your patients at least on one occasion before entry into the study.

I would like to add one more point, the importance of skin and soft tissue coverage of the mesh.

My technique varies from yours in that I place the mesh in an intraperitoneal position and anchor the mesh laterally as far as one needs to go to reach solid and healthy musculofascial tissue for placement of interrupted Prolene mattress sutures. With this technique our incidence of enterocutaneous fistula has been very low, and I think the important factor has been the soft tissue coverage of the mesh.
Did you have soft tissue coverage of skin and subcutaneous layers in all cases? How did you close the wound in the two patients who became infected and in whom it was necessary to remove the mesh? Was it really necessary to remove the mesh or could the deep wound infection have been handled with reoperation and drainage and leaving the mesh in place?

Third, next week if you have a patient in whom you inadvertently enter the small bowel or the colon and thus have contamination and if you did not want to use mesh repair, how would you close that wound? Fourth, what do you think the advantage of your modified Stoppa technique is over the intraperitoneal placement of the mesh?

**Dr. Temudom.** In general we prefer to use polypropylene mesh because its woven nature allows complete tissue ingrowth and abdominal wall stability. However, we will use expanded polytetrafluoroethylene in two situations. First, when the patient has ascites, polytetrafluoroethylene offers a watertight closure. Second, when no autogenous tissue is present between the bowel and the prosthetic material, we use polytetrafluoroethylene because we believe that the development of fistula is less. We have no data to support this belief, however, other than the lack of significant ingrowth into the polytetrafluoroethylene.

In two patients we had to remove the prosthetic mesh because the patients had purulent material or intestinal content that contaminated the whole part of mesh. We removed the mesh totally early in the postoperative period before complete tissue incorporation. We then packed the wound and let the wound heal by secondary intention.

In those situations in which permanent mesh is contraindicated, we do attempt to reapproximate the fascia, even if under some tension. If this is impossible, we will use an absorbable mesh such as Vicryl mesh to patch a defect as an external onlay graft.

On several occasions we have preserved the sac (especially if it is thickened) and completed the intraabdominal procedure, and we then reapproximated the hernia sac and the skin without any prosthetic material. The patient was then kept in an abdominal binder for several weeks after operation. All these patients obviously will have a ventral hernia, and we tell them to expect that.

**Dr. Philip Donahue** (Chicago, IL). I have a technical question about this concept of behind the rectus muscle but in front of posterior rectus fascia. That is the place where you described your mesh. What happens when you get to the borders of the rectus sheath? With really large hernias the Stoppa technique implies really broad spreading of the prosthetic mesh beyond the confines of rectus sheath, which has a rather limited distribution lower on the abdominal wall.

What do you do when you dissect that rectus muscle from the posterior rectus sheath? What do you do at the spigelian line (i.e., the semilunar line)? Do you just break through that?

**Dr. Temudom.** We have undermined bilaterally and then extended beyond the midclavicle line to the anterior axillary line along the plane between the abdominal wall and peritoneum and fixed the mesh with the abdominal wall.

**Dr. Jim Monge** (Duluth, MN). Our early experience with patients with recurrent incisional hernias was that onlay grafts did not hold up. A deeply placed, underlaid graft has yielded a much lower frequency of recurrence, as you have also described.

We always save some attenuated tissue to cover the graft anteriorly to separate it from the subcutaneous tissue. Our experience has been that these patients frequently form seromas that may become septic. If infection develops in the seroma, it does not involve the graft material and the graft has not required removal. Placement of suction catheters has decreased seroma formation and allows several days of irrigation with a multiple antibiotic solution. This has markedly decreased the incidence of infection.