Surgical Progress in Inguinal and Ventral Incisional Hernia Repair

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Repair of abdominal wall hernias represents the most common group of operations performed by general surgeons. In 2003 it was estimated that over 700,000 inguinal hernia repairs and over 100,000 ventral incisional hernia repairs were performed [1]. The field of hernia repair has evolved as a result of surgical innovation and has benefited significantly from technologic improvements. The tension-free repair is one of the key concepts that have revolutionized hernia surgery. The use of a mesh prosthesis to approximate the fascial defect has resulted in a decrease in recurrence rates for inguinal and incisional hernias. More recently, laparoscopic approaches to the inguinal and incisional hernia have extended the options and approaches for repairing the fascial defect. As opposed to tension-free repair, the results of laparoscopic approaches for inguinal and incisional hernia repair have been mixed, and these approaches have not been rapidly embraced by surgeons. The goals of this article are to describe the history of hernia repair and how innovations in surgical technique, prosthetics, and technology have shaped current practice.

Open techniques

In 1887, the Bassini inguinal hernia repair heralded the beginning of contemporary inguinal hernia surgery. Numerous modifications to the Bassini repair emerged in an attempt to decrease the recurrence rate. High
recurrence rates due to tension at the repair site were addressed with a variety of innovations. First, a relaxing incision to reduce tension was included in the repair and is still performed commonly today in a McVay [2] (Cooper’s ligament) repair. Another modification of the Bassini repair, the Shouldice repair, achieved excellent results in the hands of its originators; however, the Shouldice repair failed to gain widespread use due to its technical difficulties and inconsistent results outside the Shouldice clinic [3,4]. Stoppa described a preperitoneal approach in 1975 for complicated and recurrent hernias. The Stoppa repair used a large mesh in the preperitoneal space to support the fascial defect, which is the concept upon which the laparoscopic inguinal hernia repair is based. In 1986, the tension-free inguinal hernia repair with mesh was described by Lichtenstein [5,6]. The Lichtenstein repair has become the most popular open technique for inguinal hernia repair and has been shown to have superior recurrence rates when compared with tissue-based hernia repair [7–9]. The Lichtenstein repair is attractive to many surgeons because of the simplicity of the repair, the reproducible low recurrence rates, and the decreased postoperative pain experienced by patients.

The concept of plugging the inguinal canal with foreign material and tissue to repair defects began in the mid-nineteenth century (Fig. 1). In 1987, Gilbert refined the mesh plug technique into the cone or umbrella shape, which Rutkow and Robbins developed into the preformed cone that is now commercially available [10–12]. A recent randomized controlled trial found the mesh plug and Lichtenstein repair to have comparable recurrence rates [13]. Further developments of the mesh repair have sought to combine the anterior approach as used by Lichtenstein with a posterior reinforcement as used in the laparoscopic and Stoppa repair. One such product popularized by Gilbert is the Prolene Hernia System (Ethicon, Cincinnati, Ohio) that combines two sheets of mesh linked by a connector. The posterior sheet of mesh is placed into the preperitoneal space, and the anterior mesh reinforces the repair. Results from a retrospective study suggest that the Prolene Hernia System may represent a superior alternative for open repair of inguinal hernias [14]. Further prospective randomized trials are necessary to confirm or refute these findings.

Although advances in inguinal hernia repair have resulted in significant improvements in surgical and patient reported outcomes, the repair of ventral incisional hernia has been more challenging. Recent data from a prospective randomized controlled trial of suture versus mesh repair in ventral incisional hernia revealed superior results with the mesh repair [15]. Analysis of a population-based registry revealed that the rate of mesh placement for ventral incisional hernia repair has increased from 35% in 1987 to 66% in 1999 [16]. Current practice for the repair of incisional hernias is the selective placement of mesh in patients based on the surgeon’s preference and experience [17]. Fear of mesh infection and fistula
Rectus Femoris Flap for Ventral Hernia Repair

Mesh Plug Inguinal Hernia Repair

Polypropylene used for Inguinal Hernia Repair

Stoppa Preperitoneal Repair

Solid PTFE used for Inguinal Hernia Repair

Polypropylene used for Inguinal Hernia Repair

McVay (Cooper Ligament) Repair

Mesh Plug Inguinal Hernia Repair

Silver Mesh Utilized in Ventral Hernia Repair

Bassini Inguinal Repair

Shouldice Inguinal Hernia Repair

Tensor Fascia Lata Flap for Ventral Hernia repair

Laparoscopic Inguinal Hernia Repair

Lichtenstein Repair

Rectus Femoris Flap for Ventral Hernia Repair

Plug and Patch Inguinal Hernia Repair

Prolene Hernia System for Inguinal Hernia Repair

Component Separation Technique for Ventral Hernia Repair

Fig. 1. Timeline of hernia repair.
formation continue to limit the systematic use of mesh in ventral incisional hernia repair. Innovative techniques in the repair of ventral incisional hernias that reduce tension without the use of prosthetic material include the component separation technique and the use of preoperative tissue expansion. The component separation technique was initially reported in 1990 and is based on enlargement of the abdominal wall surface by separation of the anterior abdominal muscular layers [18]. Because no prosthetic material is required, this technique can be used in contaminated wounds [18,19]. Recently published interim data demonstrate favorable outcomes when comparing component separation with prosthetic mesh repair [19].

Preoperative tissue expansion can be used to facilitate reapproximation of tissue without tension. Two reported methods of tissue expansion consist of progressive pneumoperitoneum and implantation of tissue expanders. Progressive pneumoperitoneum has been described in case reports and case series. Advantages include the detection of multiple fascial defects, approximation of natural tissues without tension, and preoperative lysis of adhesions [20,21]. Progressive pneumoperitoneum is achieved by insufflation of air at regular intervals via percutaneous puncture or indwelling intra-abdominal catheters [22]. The use of implanted tissue expanders was first described to repair congenital and posttraumatic defects [23]. Gradual expansion is thought to provide natural innervated healthy tissue that can be used for reapproximation of the fascial defect. Expanders can be placed in the subcutaneous, intermuscular, intramuscular, and intra-abdominal positions.

More complex abdominal wall reconstructions have been described. Use of the tensor fascia lata flap was described to close lower abdominal wall defects in 1946 and use of the rectus femoris in 1977 [24,25]. Recently, use of a free vascularized composite anterolateral thigh flap with tensor fascia lata has been described [26]. Complications associated with flaps include donor site morbidity, flap necrosis, flap shrinkage, and hernia recurrence [25,27].

Prosthetic material

Synthesis of plastic began in the twentieth century, and nylon was the first material widely available as suture. Publications document the use of nylon mesh during World War II in France [28]. Unfortunately, nylon loses tensile strength due to hydrolysis and denaturation and is associated with hernia recurrence. During the 1950s and 1960s, polypropylene and Dacron were introduced [28]. Usher used polypropylene prosthesis in 1958 for inguinal and incisional hernia repair. In the repair of incisional hernias, he placed oversized mesh deep to the abdominal wall musculature to allow for adequate overlap. By 1962, a survey documented that 20% of general surgeons were using techniques advocated by Usher [29]. Polypropylene is inexpensive, easy to handle, and incorporates well into the abdominal wall. Clinical experience with polypropylene has demonstrated some complications when
it is placed intraperitoneally, including adhesion formation, erosion into abdominal viscera, and fistula formation [30–33].

Direct contact between abdominal viscera and prosthetic material can cause an inflammatory reaction leading to adhesion formation [34,35]. The development of postoperative adhesions has significant clinical consequences. Intestinal adhesions not only result in future bowel obstructions, female infertility, and abdominal pain but also increase the risk of bowel injury during subsequent abdominal surgery [36,37]. Postoperative adhesions have been shown to increase subsequent operative time, the conversion rates from laparoscopic to open procedures, and the incidence of postoperative complications [37–40].

To reduce these complications, solid polytetrafluoroethylene (PTFE) was used for the first time in hernia surgery in 1959. Solid PTFE was plagued by high recurrence rates due to low tensile strength and lack of incorporation within tissue [41]. Expanded PTFE (ePTFE) was later developed in Japan and was used mainly in the intraperitoneal position [28]. Unlike polypropylene, ePTFE has a low incidence of visceral erosion, bowel obstruction, fistulization, abscess formation, and, due to rapid coverage with mesothelium, less adhesion formation [42–44].

Another strategy to reduce adhesion formation and visceral erosion is the use of composite meshes which have been shown to form fewer adhesions of weaker strength [45]. Composite meshes generally consist of two sides—a “non-tissue ingrowth” side that faces viscera and a “tissue incorporating” side against the abdominal wall. Animal studies have demonstrated decreased rates of adhesion formation 1 year after implantation of composite mesh when compared with polypropylene mesh [30].

The implantation of mesh and the resultant inflammatory reaction may also lead to the formation of a rigid scar plate with loss of abdominal wall pliability and changes in abdominal wall compliance. Patients may complain of a sensation of stiffness, physical discomfort, and limitations in activities of daily living. Light weight meshes with reduced polypropylene content and larger pore size have demonstrated reduced inflammation and improved integration into surrounding tissues in animal studies [46]. In addition, light weight meshes have been associated with decreased complaints of pain, paresthesias, and improved abdominal wall compliance [47]. Animal studies demonstrate that light weight polypropylene mesh results in less restriction of abdominal wall compliance while providing adequate repair strength [48].

Recently, several absorbable and biologic prostheses have become commercially available. Hernia repair in the setting of a contaminated surgical field requires either a staged repair or primary tissue repair. Absorbable poliglactin (Vicryl) prosthetics have been used for hernia repair associated with contaminated operative fields [49]. The hypothesis behind using absorbable prosthetic material is that the mesh can support the ingrowth of host repair tissues and then degrade when the repair is functionally stable. Biologic
prostheses are useful when the wound is contaminated or the risk of infection is high. Acellular dermal matrix, porcine intestinal mucosa, and porcine dermal collagen have been used safely and effectively as an alternative to traditional mesh to successfully repair hernias in contaminated operative fields and in conditions that would not have been safe for traditional permanent mesh prosthesis [50–53]. Long-term data on hernia outcomes using these expensive biologic mesh products are lacking.

**Laparoscopic hernia repair**

The first laparoscopic inguinal hernia repair was performed in 1982 and consisted of intra-abdominal closure of the neck of the hernia sac [54]. In 2003, 14% of 800,000 groin hernias were repaired laparoscopically [1]. There are two accepted approaches to laparoscopic inguinal hernia repair: (1) the totally extraperitoneal (TEP) approach using the principles of preperitoneal repair originally described by Stoppa, and (2) the transabdominal preperitoneal repair (TAPP). The major difference between the TEP and TAPP technique is the access to the preperitoneal space. The TEP repair does not violate the peritoneal cavity and is thought to decrease the risk of bowel and bladder injury. A recent meta-analysis could not find evidence to support either technique as superior [55].

There is considerable debate about which patients should undergo laparoscopic inguinal hernia repair. The results of the multicenter, randomized Department of Veterans Affairs Cooperative study found a higher recurrence and complication rate among patients who had laparoscopic inguinal hernia repair [56]. In addition, the study found that patients who underwent laparoscopic inguinal hernia repair had less initial pain and returned to normal activities faster than patients who underwent an open repair. Although some studies suggest that laparoscopic inguinal hernia repair is not cost effective [57,58], the Veterans Affairs study revealed that laparoscopic repair while not cost effective overall is a cost-effective option for unilateral hernia repair [59]. A Swedish multicenter trial of inguinal hernia repair reported similar recurrence rates among patients who underwent laparoscopic or Shouldice repair [60]. The Veterans Affairs study also illustrates the learning curve associated with laparoscopic inguinal hernia repair as evidenced by the significantly lower recurrence rate among surgeons who have completed greater than 250 laparoscopic repairs [56].

There is significant debate among experts regarding the optimal approach for ventral incisional hernia. Advocates of laparoscopic repair argue that it is a better approach because it does not require extensive subcutaneous tissue dissection and postoperative drainage. In addition, sublay mesh placement appears to be the most physiologic method of ventral incisional hernia repair [61]. Studies have associated laparoscopic repair with a shorter length of hospitalization, lower wound infection rates, shorter operative
time, and earlier return to work [62–64]. Recently published studies have found that laparoscopic repair of ventral hernias in obese patients and patients with large fascial defects is safe and associated with a low recurrence and complication rate [62–64]. The most common complication of laparoscopic ventral incisional hernia repair is seroma formation, which occurs in 10% to 15% of cases. The occurrence of an unrecognized enterotomy or bowel injury resulting in sepsis or death is the most feared complication of ventral incisional hernia repair [65]. Rates of bowel injury during laparoscopic and open ventral hernia repair range from 7.2% to 9% [40,66].

Summary and future directions

Contemporary repair of abdominal wall hernias is supported by strong evidence and calls for a tension-free repair with placement of mesh in the majority of cases. Laparoscopic repair demands significant expertise to achieve outcomes comparable with those of open repair. In ventral incisional hernias, placement of the mesh in a sublay position has been found to be effective and to have a low recurrence rate, although randomized trials have not been performed [67].

In a paradigm shift, the necessity of inguinal hernia repair upon diagnosis in relatively asymptomatic men is now questioned [68]. With improvements in recurrence and complications, emphasis is now placed on patient-centered outcomes and increasing the benefits of surgery over the risks and complications while obtaining the best physiologic outcome [69].

Several milestones were achieved with the use of prosthetic material, and the new bioprostheses hold promise in decreasing inflammatory reaction and improving physiologic results. Future research will continue to focus on the indications for surgery as well as on surgical techniques and materials to achieve the best patient-centered outcomes and functionality.

References


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