Examining modern approaches to inguinal and femoral herniorrhaphy

The newest hernia repair techniques, including the various laparoscopic approaches, require continued learning and practice by the surgeon to develop and maintain proficiency.

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Groin hernias are the most common clinical problem addressed by surgeons, with more than 700,000 repairs performed annually in the United States alone.[1,2] This article reviews the basics of hernia repair in 2008. The authors describe the anatomic features that differentiate groin hernias and provide factors the PA should consider when evaluating a patient with a hernia. Discussion of the various classification systems for hernias shows proper methods for documenting the type of hernia. A chronologic review of types of hernia repair helps the reader to visualize how techniques have progressed and where the future of hernia surgery lies. After completing this article, the reader will gain a better understanding of how best to educate patients, whether in a primary care or surgical setting, about the various treatment options for groin hernias.

DEFINITIONS

The word *hernia* comes from the Latin for *rupture* and the Greek for *bud*.[3] A *groin hernia* is any protrusion of the intra-abdominal contents through a muscular defect. Hernias may occur in areas devoid of striated muscle. They are a common cause of bowel obstruction. Hernias may be chronic or may incarcerate and lead to strangulation of bowel. Strangulation occurs in 1% to 3% of all hernias and results in compromised blood flow to the entrapped contents.[3]

It is important to realize that although an incarcerated hernia is irreducible or "stuck," patients may have chronically incarcerated hernias without strangulation.[4] However, incarcerated hernias increase the risk of later strangulation as a result of swelling of the trapped contents. In patients who present acutely with a hernia, the greatest risk of strangulation is in the first 3 months.[3] Strangulated hernias have a 10% operative mortality rate, which is 10 times higher than the mortality rate for an elective hernia repair.[5]

ANATOMY AND PATHOPHYSIOLOGY

Hernias of the groin comprise approximately 75% of all hernias and are more common in men.[2] Inguinal hernias may be classified as *indirect* or *direct*. Indirect hernias represent the most common type of hernia in both men and women and are termed such because of their indirect route of passage through the internal ring.[6]

Indirect hernias that occur in men are the result of a congenital defect called a *patent processus vaginalis*. The processus vaginalis is an outpouching of the peritoneum, which may be viewed much like the finger of a glove, that allows for descent of the testicle into the scrotum, as directed by the gubernaculum, during fetal development.[4] The processus vaginalis typically closes by age 2 years in male children, but retained patency is found in 20% of adult males, providing

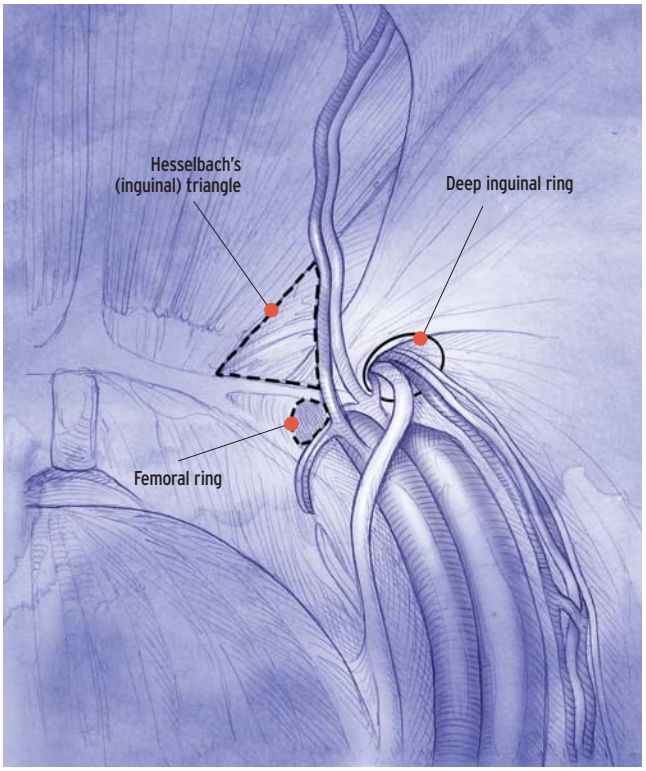

FIGURE 1. The borders of a direct inguinal hernia are identified by the triangle superior to the inguinal ligament. The site for femoral herniation is indicated by the circular dotted line beneath the inguinal ligament. The deep inguinal ring is the origin for indirect hernias.

potential for communication with the abdominal cavity.[3] Although retained patency is common and increases risk for indirect herniation, the lifetime incidence of inguinal hernia is estimated to be as low as 5%.[4]

The internal ring is a natural opening, formed by the external oblique (external ring) and the transversus abdominus (deep ring), allowing for the passage of the spermatic cord in men and the round ligament in women. Stretching or muscle deficiency surrounding this opening also provides opportunity for indirect herniation to develop. Indirect hernias are more commonly found on the right, which is attributed to delayed descent of the right testicle in men and subsequent delay in the atrophy of the processus vaginalis that normally follows this descent.[3]

Direct hernias result from a weakened transversalis fascia and protrude directly through the abdominal wall. Direct hernias occur in what is described as Hesselbach's triangle. The borders of this triangle are made up laterally by the inferior epigastric vessels, medially by the lateral edge of the rectus muscles, and inferiorly by the inguinal ligament. Direct hernias occur more commonly in older men with a weakened transversalis fascia.

Direct hernias are typically the result of a chronic process of increased intra-abdominal pressure from long-term heavy lifting, aging, chronic coughing, and/or cigarette smoking. Connective tissue disease and collagen vascular disease also predispose to the development of direct hernias. Direct and indirect hernias can occur simultaneously, in which case they are referred to as *pantaloon hernias*, because the two hernias straddle the inferior epigastric vessels, forming the appearance of pantaloons.

Femoral hernias make up 2% to 4% of all groin hernias and are more common in females.[2,3,6] They are also more frequently found on the right side because of the anatomic position of the sigmoid colon, which provides somewhat of a tamponade effect on the femoral canal on the left.[3] The femoral canal tends to be larger and more oval in shape in females, causing them to be at a higher risk for herniation. Pregnancy also causes the pelvic attachments to stretch, further increasing risk in females. Femoral hernias have up to a 40% risk of strangulation as a result of the rigid confines of the femoral canal.[3] Femoral hernias occur beneath the inguinal ligament and medially to the femoral vessels (see Figure 1, page 35).

The major nerves in the inguinal region include the ilioinguinal, the iliohypogastric, and the genitofemoral nerves. The most common nerve injured during open inguinal herniorrhaphy is the ilioinguinal. This nerve is located in close proximity to the external inguinal ring and provides unilateral sensory innervation to the pubic region and upper portion of the scrotum or labia majora. The iliohypogastric nerve courses superiorly to the deep inguinal ring and supplies sensory innervation to the skin above the pubis. The genital branch of the genitofemoral nerve passes with the spermatic cord into the scrotum to innervate the scrotum and medial thigh. The lateral branch forms the lateral femoral cutaneous nerve that provides sensation to the skin of the lateral portion of the anterior thigh.[6]

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DIAGNOSIS

Typically, the diagnosis of an inguinal or femoral hernia is straightforward and is easily made when the patient reports a bulge in the groin or scrotum. Physical examination of the inguinal canal while the patient performs a Valsalva maneuver or coughs will often elicit the hernia. When the diagnosis of a hernia is uncertain, however, abdominal CT or ultrasound can be helpful next steps. Signs suggesting potential strangulation include erythema of the overlying skin, an elevated WBC count, and fever. In patients presenting with obstipation, herniation should always be considered as a potential source.

Several different classification systems for hernias have been developed, with no particular method having gained universal use. The most frequently used systems are the tra-

KEY POINTS

- Groin hernias are the most common clinical problem addressed by surgeons, with more than 700,000 repairs performed annually in the United States alone.
- Inguinal hernias may be classified as indirect or direct. Indirect hernias represent the most common type of hernia in both men and women. Femoral hernias make up 2% to 4% of all groin hernias and are more common in females.
- Most surgeons say that the mere presence of a hernia is sufficient reason for repair. In patients with comorbidities, however, the risk versus benefit must be weighed.
- Modern hernia repair methods include open mesh repair, including repair using the Prolene Hernia System; and laparoscopic techniques, including the transabdominal preperitoneal prosthetic (TAPP) procedure and the totally extraperitoneal prosthetic (TEP) repair. Preference for repair is typically based on the knowledge and experience of the surgeon.

COMPETENCIES

- ●●●●● Medical knowledge
- ● Interpersonal & communication skills
- ● Patient care
- ● Professionalism
- ●●● Practice-based learning and improvement
- ●●●●● Systems-based practice

TABLE 1. Differences between groin hernia classification systems

Classification system	Type	Description
Nyhus/Stoppa	I	Indirect, normal internal ring
	II	Indirect, enlarged internal ring
	III-A	Direct
	III-B	Indirect, largely dilated internal ring expanding into the direct space (includes pantaloon)
	III-C	Femoral
	IV-A	Recurrent direct
	IV-B	Recurrent indirect
	IV-C	Recurrent femoral
	IV-D	A combination of IV-A through IV-C
Gilbert/Rutkow and Robbins	I	Indirect, normal internal ring
	II	Indirect, moderately enlarged internal ring (<2 fingerbreadths)
	III	Indirect, large internal ring (≥2 fingerbreadths)
	IV	Direct; large or blowout of the direct floor with intact internal ring
	V	Direct, defect ≤1 fingerbreadth, intact internal ring
	VI	Pantaloon
	VII	Femoral

Data from Zollinger RM Jr.[7]

ditional descriptions of groin hernias as indirect, direct or femoral; the Nyhus/Stoppa system; and the Gilbert/Rutkow and Robbins system.

The Nyhus/Stoppa classification was initially proposed in 1993. Stoppa added "aggravating factors" to the Nyhus system—specifically, obesity, collagen vascular disorders, and complexity. When present, each of these factors increases the stage by one level (that is, a type I hernia escalates to a type II hernia). Gilbert called his classification the Cooperative Hernia Analysis of Types and Surgery. This system was devised in 1989 and included five different levels for indirect and direct hernias. Rutkow and Robbins expanded on Gilbert's scheme in 1993 by adding a type VI for pantaloon hernias and a type VII for femoral hernias (see Table 1). A 1998 survey of members of the American Hernia Society revealed that approximately 50% of surgeons used the traditional method, 30% used the Nyhus/Stoppa method, and 20% used the Gilbert/Rutkow and Robbins system to classify hernias.[7]

TREATMENT

Indications for repair Most surgeons say that the mere presence of a hernia is sufficient reason for repair. However, in patients with comorbidities, the risk versus benefit must be weighed. The overall mortality rate for elective hernia repair increases with age. Risk is approximately 0.1% in patients younger than 60 years and as high as 3.3% in those older than 80 years.[5] Factors to consider include whether the hernia is symptomatic, the size of the hernia defect, and the risk of incarceration.

Patients who elect to delay surgical repair should be counseled on the need for re-evaluation if they can no longer manually reduce the hernia easily or if they become symptomatic. For patients who cannot tolerate general anesthesia, open repairs may be performed using local anesthesia, with or without IV sedation. Historically, patients have been prescribed a truss to keep a hernia reduced. However, use of a truss can increase scarring and cause swelling and is indicated only in patients who cannot tolerate surgery and have a reducible inguinal hernia. A truss should never be used for a femoral hernia.

The goals of herniorrhaphy include minimizing operative and postoperative discomfort for the patient, achieving an effective repair, ensuring the lowest possible recurrence rate, permitting a rapid return to normal activities, and performing a cost-effective procedure. For these reasons, multiple methods of repair have been utilized.

Repair methods Over the past century, techniques of herniorrhaphy have progressed from open repair to various laparoscopic approaches. One of those early techniques was performed by Henry Orlando Marcy in 1871. The Marcy repair is a simple ring closure, which involves high ligation of the hernia sac and obliteration of the deep internal ring with permanent sutures. Marcy repairs are still commonly used

in the pediatric population. Also in the late 1800s, Edoardo Bassini developed a procedure for herniorrhaphy that involves high ligation of the hernia sac and reinforcement of the inguinal canal with a three layer closure with interrupted permanent sutures. The Bassini repair is typically used for direct and indirect hernias. In 1942, Chester McVay devised the Cooper's ligament repair. This procedure is used for direct, indirect, and femoral hernias. It involves suturing the transverse aponeurotic arch to Cooper's ligament medially, anchoring to the femoral sheath, and to the iliopubic tract laterally. Cooper's ligament repair requires dissection through the medial portion of the iliopubic tract and relaxing incisions to prevent excessive tension. In 1952, Earle Shouldice developed a modified Bassini repair that utilizes continuous (rather than interrupted) wire sutures under local anesthesia.[3,6]

The era of mesh repair began in the late 1950s when F. C. Usher, a surgeon at Baylor College of Medicine, experimented with polyethylene, which was later adapted to form a polypropylene mesh that has a quick response from fibroblasts, allowing rapid incorporation into the body.[3,8] Clinical trials performed in Europe showed that open repairs with the use of mesh reduced hernia recurrence rates by 50% to 75%.[1] The use of mesh produced less pain for the patient and allowed for quicker recovery.

Macroporous mesh is preferred to allow for infiltration of macrophages, fibroblasts, collagen fibers, and factors of angiogenesis. Pore size must be at least 75 microns to allow for this infiltration.[9] Smaller pore size would enable bacteria to pass where the macrophages and neutrophils cannot. It is common practice to administer one preoperative dose of IV antibiotics, such as 1 g of cefazolin (Ancef), whenever mesh is to be placed.

"Prolene Hernia System repairs have demonstrated effective results whether performed by hernia specialists or by general surgeons."

Lichtenstein popularized the open mesh repair in 1980 with his "tension-free" hernioplasty technique, which utilizes a slit in the mesh to accommodate passage of the spermatic cord and is sutured circumferentially to the internal oblique, rectus sheath, and inguinal ligaments.[3] Lichtenstein also advocated using polypropylene mesh plugs for the anterior, infrainguinal repair of femoral hernias.

In 1987, Gilbert invented a sutureless hernia repair by means of a plug technique to block the internal ring from passage of indirect hernia sacs. In the early 1990s, Robbins and Rutkow expanded on Gilbert's technique and began using "plug and patch" repairs on indirect and direct hernias of all sizes. Cone-shaped plugs were inserted into the hernia defect and then covered with an onlay of mesh.

The problems with the plug and patch procedures were that the mesh would migrate and shrink, creating potential for recurrence and foreign body sensation. Mesh plugs may shrink up to 75% after implantation.[9] To prevent these complications, Gilbert and Graham devised a bilayer mesh with internal connector in 1998. This involved using the internal ring as access to the preperitoneal space. The connector virtually eliminated migration.

The Prolene Hernia System (PHS) is an example of this repair and allows full coverage for direct and indirect hernias. The mesh is fixed to the surrounding tissue using sutures, staples, or tacks. PHS repairs have demonstrated effective results when made by both hernia specialists and general surgeons who do not primarily focus on herniorrhaphy.[10] Also, the PHS has been shown to reduce operative time and to allow quicker patient return to normal activity as compared with the Lichtenstein patch technique.[11]

Laparoscopic techniques These approaches to inguinal hernia repair made their debut in 1991 with the intraperitoneal onlay of mesh (IPOM) technique that was developed by Toy and Smoot. No dissection was done, and mesh was simply stapled over the hernia defect intraperitoneally.[12] The IPOM technique was found to present an increased risk of intra-abdominal adhesions.

In 1993, Arregui and colleagues described the transabdominal preperitoneal prosthetic (TAPP) procedure.[13] The abdomen is entered laparoscopically and the inguinal peritoneum incised, requiring closure of the entry point upon completion of the repair. Benefits of the TAPP technique include the ease of landmark recognition, ability to take down adhesions, facilitation of diagnosis of other intra-abdominal conditions, or determining diagnosis when one is unclear, as is common in females.

In 1993, McKernan and Laws introduced the totally extraperitoneal prosthetic (TEP) repair. This technique emerged from an open repair popularized by Stoppa in 1975, which involved placement of a large, unsutured polyester prosthesis preperitoneally to repair inguinal hernias. Intra-abdominal pressure was utilized to hold the mesh in place until it was incorporated by new connective tissue growth.[14] In contrast, the laparoscopic TEP repair involves balloon insufflation to create a potential space between the peritoneum and the transversalis fascia. This space is also referred to as the preperitoneal space of Bogros.[13] The hernia is dissected well away from the defect and mesh is tacked into place.

This technique offers lower risk of injury to intraperitoneal structures and avoidance of adhesions. Another benefit of the TEP repair is that the peritoneum does not have to be closed because it is not entered. In the event that a tear in the peritoneum occurs during the dissection, the resultant pneumoperitoneum may compromise the extraperitoneal space. A Veress needle can be inserted to provide decompression of the pneumoperitoneum. If this is ineffective, the TEP can be converted to a TAPP for completion of the procedure. Contraindications to TEP include previous TEP, because the

preperitoneal space cannot be recreated; previous open prostatectomy; or very large or incarcerated hernias.

The open, mesh-based repairs are referred to as anterior repairs and the IPOM, TAPP, and TEP procedures are considered to be posterior repairs. The PHS is both an anterior and posterior repair because the internal ring is used to access the posterior preperitoneal space, whereas the internal connector occludes the ring and joins to an anterior layer of mesh. Advocates of preperitoneal repairs have argued that a posterior repair is a more anatomic approach.[13] The major deterrent to laparoscopic repair is the need for general anesthesia.[14] However, many surgeons still prefer general anesthesia for open repairs as well.

> "Surgeons who were experienced at laparoscopy had no significant difference in recurrence rates for laparoscopic versus open repairs."

Choosing a repair method Although a laparoscopic TAPP or TEP procedure is now an increasingly popular technique for hernia repair, both are quite limited by the experience of the surgeon. Mastering quick and efficient laparoscopic repairs requires a significant learning curve.[15]

A 2004 Veterans Affairs (VA) study indicated a 5% lower recurrence rate for open, mesh-based inguinal hernia repair as compared with laparoscopic repair.[16] Yet experienced laparoscopic surgeons had no significant difference in recurrence rates for laparoscopic versus open repairs. Although the VA study set the learning curve for experienced laparoscopic surgeons at the first 250 cases, other studies have shown significant reductions in recurrence rates after the surgeon has performed the first 25 to 30 laparoscopic repairs.[15,16] With contemporary open, tension-free techniques, 2% to 5% of patients experience hernia recurrence and require another repair.[16,17] In comparison, laparoscopic repairs have been shown to have recurrence rates as low as 0.29% to 2%.[18] The most common causes for recurrence after laparoscopic repair are improperly sized and anchored mesh.[18,19]

In cases of recurrence, the method of repair depends on the type of initial repair. If the previous repair was an open, anterior repair, a TAPP or TEP procedure may then be performed. Recurrent hernias after posterior or laparoscopic repair may require an open mesh-fixation technique, such as the PHS. Very large hernias or incarcerated hernias are better repaired with an open, mesh-based repair.

POSTOPERATIVE COMPLICATIONS AND OTHER CONSIDERATIONS

Common complications following herniorrhaphy include seroma, ecchymosis of the penis or scrotum, and urinary retention (particularly in older males with a history of prostatism). The risk of infection or significant hematoma is approximately 1% following hernia repair.[17] Chronic groin pain (inguinodynia) after groin hernia repair may be seen in approximately 5% of patients. Chronic inguinodynia is a difficult problem to treat and may require multimodality pain management or further surgery.[17] This emphasizes the importance of recognizing and avoiding the nerves intraoperatively.

A 2005 review of hernia repairs showed that patients who underwent laparoscopic repairs returned to usual activity and work 4 days sooner on average than did those patients who underwent open repairs. Patients who underwent laparoscopic repairs also showed significantly lower pain scores postoperatively than did those who had open repairs. Among the drawbacks to the laparoscopic repair are an approximately 15-minute longer operative time and greater overall cost of the procedure compared to open repair.[20]

Conclusion Although modern forms of hernia repair have existed since the 1800s, the techniques continue to evolve. Preference for repair is typically based on the knowledge and experience of the surgeon. PAs should be prepared to educate their patients about the various methods and their associated benefits. JAAPA

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REFERENCES

1. Neumayer L, McGregor DB, Mann B. Abdominal wall, including hernia. In: Lawrence PF, ed. *Essentials of General Surgery*. 4th ed. Baltimore, MD: Lippincott, Williams & Wilkins; 2006:225-237.
2. Manthey D, Nicks, BA. Hernias. eMedicine Web site. www.emedicine.com/emerg/topic251.htm. Updated January 3, 2007. Accessed May 13, 2008.
3. Wantz GE. Abdominal wall hernias. In: Schwartz SI, ed. *Principles of Surgery*. 7th ed. New York, NY: McGraw-Hill; 1999:1585-1611.
4. Oakes D. Hernias. In: Niederhuber JE, ed. *Fundamentals of Surgery*. 1st ed. Stamford, CT: Appleton & Lange; 1998:390-401.
5. Groin hernias. Surgical-tutor.org Web site. http://www.surgical-tutor.org.uk/specialities/general/hernias.htm. Accessed May 13, 2008.
6. Bax T, Sheppard BC, Crass RA. Surgical options in the management of groin hernias. *Am Fam Physician*. 1999;59(1). http://www.aafp.org/afp/990101ap/143.html. Accessed May 13, 2008.
7. Zollinger RM Jr. A unified classification for inguinal hernias. *Hernia*. 1999;3(4):195-200.
8. Read RC. The contributions of Usher and others to the elimination of tension from groin herniorrhaphy. *Hernia*. 2005;9(3):208-211.
9. Amid PK. Classification of biomaterials and their related complications in abdominal wall hernia surgery. *Hernia*. 1997;1(1):15-21.
10. Gilbert AI, Young J, Graham MF, et al. Combined anterior and posterior inguinal hernia repair: intermediate recurrence rates with three groups of surgeons. *Hernia*. 2004;8(3):203-207.
11. Kingsnorth AN, Wright D, Porter CS, Robertson G. Prolene Hernia System compared with Lichtenstein patch: a randomized double blind study of short-term and medium-term outcomes in primary inguinal hernia repair. *Hernia*. 2002;6(3):113-119.
12. Toy FK, Smoot RT Jr. Toy-Smoot laparoscopic hernioplasty. *Surg Laparosc Endosc*. 1991;1(3):151-155.
13. Arregui ME, Navarrete J, Davis CJ, et al. Laparoscopic inguinal herniorrhaphy techniques and controversies. *Surg Clin North Am*. 1993;73(3):513-527.
14. McKernan JB, Laws HL. Laparoscopic repair of inguinal hernias using a totally extraperitoneal prosthetic approach. *Surg Endosc*. 1993;7(1):26-28.
15. Edwards CC II, Bailey RW. Laparocopic hernia repair: the learning curve. *Surg Laparosc Endosc Percutan Tech*. 2000;10(3):149-153.
16. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. *New Engl J Med*. 2004;350(18):1819-1827.
17. The Society for Surgery of the Alimentary Tract. SSAT patient care guidelines. Surgical repair of groin hernias. http://www.ssat.com/cgi-bin/hernia6.cgi. Accessed May 13, 2008.
18. Quilici PJ, Greaney EM Jr, Quilici J, Anderson S. Laparoscopic inguinal hernia repair: optimal technical variations and results in 1700 cases. *Am Surg*. 2000;66(9):848-852.
19. Phillips EH, Rosenthal R, Fallas M, et al. Reasons for early recurrence following laparoscopic hernioplasty. *Surg Endosc*. 1995;9(2):140-145.
20. Grunwaldt LJ, Schwaitzberg SD, Rattner DW, Jones DB. Is laparoscopic inguinal hernia repair an operation of the past? *J Am Coll Surg*. 2005;200(4):616-620.