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Selected Readings in General Surgery (SRGS) is a topic oriented, in-depth review of the field of general surgery presented eight times annually as an educational offering of the Division of Education of the American College of Surgeons. The mission of the Division of Education is to improve the quality of surgical care through lifelong learning, based on educational programs and products designed to enhance the competence or performance of practicing surgeons, surgery residents, and members of the surgical team. The intent of the publication is to analyze relevant medical literature to give the surgeon the knowledge necessary to practice state-of-the-art surgery. To accomplish this goal, the editor selects 100–125 pertinent articles from the literature for each issue. Each article is reviewed and an overview is written that places the content of these articles in the perspective of the best, day-to-day, clinical practice. In addition to the overview, 12–18 full-text articles are reprinted in each issue.

The overview is compiled with the assistance of an 18-member, international board of editors who are experts in the various focus areas that comprise the specialty of surgery. In addition, the editorial board has representation and expertise in such important fields as medical evidence evaluation, surgical education, outcomes research, standard setting, and performance improvement. SRGS is a unique resource because the overview and selected full-text articles provide the reader with the most valuable and pertinent content illuminated with informed opinion and critique. Unnecessary material is eliminated. SRGS does not present itself as infallible and the editor-in-chief takes responsibility for the content that appears in each issue. The editor-in-chief and the editorial board recognize that there is no such thing as the “average” surgical patient, and that the information in the literature must be interpreted in the light of the clinical presentation of each individual patient.

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**Literature Overview**

Editor in Chief: Lewis Flint, MD, FACS  
Associate Editor: Robert Fitzgibbons, MD, FACS

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To earn CME credit, completing the pretest is a mandatory requirement. The pretest should be completed BEFORE reading the overview and taking the posttest. Both tests must be completed online at www.facs.org/publications/srgs/cme.

1. The estimated number of groin hernia repair procedures performed annually in the United States is which of the following?
   a) 22,000
   b) 1 million
   c) 130,000
   d) 100,000
   e) 750,000

2. Which of the following is associated with an increased risk for development of a groin hernia?
   a) Trauma to the abdominal wall
   b) Weightlifting
   c) A family history of groin hernias
   d) Long-haul truck driving
   e) Cigarette smoking

3. Which structure divides the inguinal canal into medial and lateral areas?
   a) The inguinal ligament
   b) The conjoint tendon
   c) The femoral nerve
   d) The inferior epigastric vessels
   e) Cooper ligament

4. The genital branch of the genitofemoral nerve has which of the following functions?
   a) Innervation of the thigh adductors
   b) Mediation of the cremasteric reflex
   c) Sensation to the suprapubic area
   d) Sensation to the skin of the lateral thigh
   e) Motor innervation to the insertion of the rectus abdominis muscle

5. Which of the following statements is true regarding the iliohypogastric nerve?
   a) The nerve arises from the T6-T7 area of the spinal cord
   b) The nerve is a component of the autonomic nervous system
   c) The nerve is located in the inguinal canal within the substance of the cremaster muscle or round ligament
   d) The usual location of the nerve is adjacent to the conjoint tendon
   e) The nerve supplies sensation to the lateral thigh skin

6. Each of the following statements is true regarding groin hernias in women except which one?
   a) Women have a higher risk of emergency hernia operation compared to men
   b) The Shouldice hernia repair is associated with a higher recurrence rate in women compared with men
   c) More than half of recurrent hernias in women are femoral hernias
   d) Laparoscopic hernia repair is the most effective approach for women with groin hernias
   e) The most common type of groin hernia in women is a femoral hernia

7. A groin hernia with sac protrusion through the internal inguinal ring and Hesselbach triangle simultaneously is described as what type of hernia?
   a) Pantaloon hernia
   b) Incarcerated hernia
   c) Femoral hernia
   d) Sliding hernia
   e) Sports hernia
8. Which of the following statements is true regarding recurrent groin hernias in women?
   a) Most recurrences are left-sided hernias
   b) Umbilical hernia is frequently associated with recurrent groin hernia
   c) Half of recurrences are femoral hernias
   d) Most recurrent hernias present with acute incarceration
   e) Recurrence occurs commonly in women who have hernia repair before the age of 30

9. Which of the following is the most effective procedure for repairing groin hernias in women?
   a) Halsted hernia repair
   b) Cooper ligament repair
   c) Bassini repair
   d) Total extraperitoneal laparoscopic hernia repair
   e) Mesh-plug repair

10. Which of the following patients is best suited for deferral of operation and the watchful waiting approach for an inguinal hernia?
    a) A 71-year-old man with a history of myocardial infarction and an enlarging left groin bulge with pain on stair-climbing
    b) A 29-year-old man with a palpable impulse on coughing in the right inguinal canal with no other symptoms
    c) A 32-year-old woman with a visible bulge in the left groin
    d) A 33-year-old man with a palpable hernia and groin pain
    e) A 62-year-old male with a right inguinal hernia and a history of prior repair of a left inguinal hernia

11. All of the following are risk factors for crossover from watchful waiting to operation except which one?
    a) ASA class 1
    b) Married status
    c) Chronic prostatism
    d) Chronic constipation
    e) Obesity

12. Over follow-up of more than 5 years, the risk of acute incarceration and/or strangulation of a minimally symptomatic inguinal hernia in patients less than 60 is which of the following?
    a) 10%
    b) 24%
    c) 50%
    d) 0.3%
    e) 5%

13. Which of the following repair methods locates the spermatic cord in the subcutaneous space?
    a) Bassini repair
    b) McVay repair
    c) Shouldice repair
    d) Halsted repair
    e) Marcy repair

14. Recurrence of a groin hernia following replacement of the hernial sac into the preperitoneal space without ligation is observed in which percentage of patients over 5 years of follow-up?
    a) 0.1%
    b) 2.7%
    c) 1%
    d) 23%
    e) 50%

15. Early postoperative groin pain is observed in up to 8% of patients following open mesh repair of groin hernia. This rate decreases to which of the following percentages by 3 years of follow-up?
    a) 7%
    b) 5%
    c) 1%
    d) 3%
    e) 0.5%
16. All of the following statements regarding an incisional hernia in midline abdominal incisions are true except which one?
   a) The overall risk of an incisional hernia in midline abdominal incisions is 15%
   b) Risk of recurrence, overall, after incisional hernia repair is 24%–50%
   c) Chronic obstructive pulmonary disease is a risk factor for incisional hernias
   d) Postoperative wound infection is a risk factor for incisional hernias
   e) Incisional hernias are most commonly seen after elective open cholecystectomy

17. Which of the following is a risk factor for recurrence following mesh or suture repair of midline abdominal incisional hernias?
   a) Diabetes
   b) Female gender
   c) Incisional hernia following laparotomy for abdominal trauma
   d) Abdominal aortic aneurysm repair as the operation prior to hernia diagnosis
   e) History of intestinal malignancy

18. A 49-year-old man with Child’s class B cirrhosis and ascites controllable with medical therapy has an umbilical hernia with a 4 cm defect. Elective repair of this hernia is associated with which of the following mortality rates?
   a) 15%
   b) 35%
   c) 2.5%
   d) 1%
   e) 40%

19. A 55-year-old man with cirrhosis and tense ascites resistant to medical therapy has an umbilical hernia with leakage of ascitic fluid. Which of the following would be an appropriate approach to this patient?
   a) Side-to-side portal-caval shunt with repair of the hernia as an urgent procedure
   b) Sterile dressing of the wound, peritoneal-venous shunt placement, and mesh repair of the hernia
   c) Urgent suture repair of the hernia
   d) Sterile dressing of the wound, TIPS procedure, and repair of the hernia
   e) Placement of a peritoneal dialysis catheter for ascites drainage with urgent suture repair of the hernia

20. Following identification and repair of the injured tissue, what percentage of patients with “sports hernias” are able to return to competitive sports?
   a) 92%–95%
   b) 78%
   c) 51%–60%
   d) 35%–40%
   e) 85%
Welcome to Selected Readings in General Surgery (SRGS). In this issue, we will consider hernia management. Operations for hernia repair are among the most common procedures performed by general surgeons. The evolution of groin hernia management has produced open, elective procedures that can easily be performed by all trained general surgeons; many procedures can be completed using local anesthesia, and laparoscopic inguinal hernia repair can be performed by general surgeons who have laparoscopic expertise.

The most frequent inguinal hernia repair operations include the placement of a fabric prosthesis to reinforce the transversalis fascia or to cover the myopectineal orifice; these approaches are associated with reported recurrence rates of 2% or less—in fact, the most common significant postoperative complication of these types of inguinal hernia repair is chronic inguinal pain. Hernia repairs that use only native tissue, such as the Shouldice, McVay, and Desarda repairs, are associated with higher reported recurrence rates and, because of the challenges in learning to perform these repairs, are used less frequently. Instead, most native tissue repairs are used to treat patients with complicated inguinal hernias, especially those associated with bowel resection and/or infection.

Ventral/incisional hernia repair is also a common general surgical procedure; however, hernia repair site infection and repair failure, leading to recurrence, continue to be challenging problems that emerge in up to 20% of patients followed long term. One of the major challenges in the management of ventral/incisional hernia is the repair of hernias that present in a contaminated or infected field; abdominal wall defects associated with open, chronically contaminated tissue or intestinal fistula require repair using normal tissue moved into the defect area (components separation procedure or flap closure) or the use of biologic prostheses for hernia closure. Biologic closures are frequently successful, but the prostheses are very expensive and hernia recurrence is common when prosthesis resorption occurs.

Parastomal hernias will also be discussed in this issue: these hernias complicate operations that create intestinal stomas necessary for fecal diversion or urinary bladder substitutes. The prevention and management of this problem will be emphasized.

The issue will conclude with a review of articles focusing on the management of umbilical hernia, epigastric hernia, diastasis recti and, finally, inguinodynia in athletes.

I am grateful for the invaluable editorial input and assistance in article selection provided by Dr. Robert Fitzgibbons of the Department of Surgery at the Creighton University School of Medicine. Dr. Fitzgibbons is an internationally recognized expert in hernia surgery, and was kind enough to offer his personal perspectives in several of this issue’s topic discussions. I have included his perspective in the overview text; a few of his thoughts struck me as particularly valuable, and these have been included as “Dr. Fitzgibbons’ Pearls,” in relevant topic areas.
Groin Hernia

Groin hernia is a common problem encountered by general surgeons worldwide. In a review of factors that contribute to the occurrence of these hernias, Fitzgibbons and Forse, in the New England Journal of Medicine, 2015, suggested terminology that can simplify hernia discussions: the authors recommend the term “groin hernia” for indirect, direct, and femoral hernias; “inguinal hernia” is the term they recommend for indirect and direct hernias.

Fitzgibbons and Forse also cited data confirming that the lifetime risk of developing inguinal hernia is 27% for men and 3% for women in the United States; femoral hernia risk is higher among female patients than males, although indirect inguinal hernias are the most common type of hernia encountered in women (the diagnosis and management of inguinal hernia in children was a topic discussed in SRGS, Volume 40, Number 4).

The Epidemiology of Groin Hernia

Data from the Centers for Disease Control and Prevention for 1996 indicate that 541,000 operations were performed for inguinal hernias; 63,000 of these were inpatient procedures, and the remainder were ambulatory surgery procedures. Additional data from the National Institutes of Health statistics on digestive diseases in the United States report that 526,000 procedures were performed for inguinal hernias in 2006.

Additional data on the prevalence of inguinal hernia were reported in an article by Burcharth and coauthors in PLOS-One, 2013. This study reported data for the interval 2006 to 2010 in Denmark; the population studied totalled 5.64 million, and the average annual number of inguinal hernia repairs during the interval was 9,340. Direct and indirect hernias accounted for 97% of the procedures and 90% of the patients were men; femoral hernias were repaired in 3% of patients and 70.2% of this group were women. The data analysis confirmed a bimodal prevalence distribution for male patients, with the first peak occurring in the 0–5 year age range and the second in the 75–80 year age range.

The report from the National Institutes of Health (previously mentioned) states that 1,322 deaths occurred in 2010 as a consequence of inguinal hernia. Assuming that the number of inguinal hernia operations was 526,000, the overall perioperative mortality is 0.2%. Data from a multihospital study from Sweden was reported by Nilsson and coauthors in the European Journal of Surgery, 1997. The authors reviewed outcomes for nearly 5,000 inguinal hernia operations performed over a two-year interval: the operative mortality was 0.7% for elective procedures and 3.5% for emergency procedures. The data from these sources support the conclusions that inguinal hernias are common, that elective surgical procedures can be performed with a very low mortality risk, and that the mortality risk for emergency procedures is significant.

Causes & Risk Factors of Inguinal Hernia

Multiple potential causes of inguinal hernia have been reported. One of these is an inherited predisposition for the development of this disease; Burcharth and coauthors presented a systematic review of the literature on this potential cause in Hernia, 2013. This article is supplied as a full-text reprint accompanying some formats of SRGS.

The authors opened their review by citing data confirming that patients with inherited connective tissue disorders, such as Marfan syndrome and Ehlers-Danlos syndrome, are at an increased risk for developing inguinal hernias. The possibility that inherited genetic abnormalities might increase this risk led the authors to conduct this systematic review: 37 studies involving more than 37,000 patients were included. Data analysis found that a family history of inguinal hernia significantly increased hernia development risk; in addition, the risk of recurrence of the hernia following repair was increased, and recurrences tended to appear earlier following hernia repair in patients with a positive family history. A single pattern of inheritance could not be identified, though the analyzed data tended to support an autosomal dominant pattern in women with a positive family history of hernia who developed a primary inguinal hernia. The authors concluded that additional research is necessary to identify specific inheritance patterns, and they stressed that the
clinical importance of this inheritance pattern research would be to identify high-risk patients that might benefit from early hernia repair.

Additional information regarding an inherited predisposition for inguinal hernia was included in a review by Matthews and Neumayer in *Current Problems in Surgery*, 2008. The authors cited data from an Asian population-based analysis that disclosed a significant association of a family history of hernia with subsequent hernia developments in relatives; on multivariate analysis, this was the only factor that remained significant. The authors concluded that the cause of inguinal hernia is probably not traceable to a single factor, but is most likely multifactorial when there is a convergence of familial predisposition, tissue weakness, and other patient-related risk factors.

Matthews and Neumayer also noted that inguinal hernias in infants and children develop in association with a patent processus vaginalis: the migration of the testicle/spерmatic cord and the round ligament during fetal development may predispose to hernia formation as well. This said, evidence refuting this hypothesis is also offered; autopsy studies have confirmed that patent processus vaginalis is a frequent finding in autopsy examinations of patients without inguinal hernias. Ultimately, the precise reason why some patients with patent processus vaginalis develop hernias and others do not is not known.

Disorders of collagen metabolism could produce weakened tissue in the inguinal area and contribute to inguinal hernia development. Collagen Type 1 is thought to be the main contributor to the strength of the abdominal wall: the collagen-rich layers of the abdominal wall are constantly undergoing remodeling, and disorders of this remodelling process could weaken the inguinal areas and increase hernia risk. Collagen remodelling is controlled, in part, by the activities of two enzymes, matrix metalloproteinase-2 (MMP-2) and tissue inhibitor of matrix metalloproteinase-2 (TIMP-2). MMP-2 enhances collagen breakdown and TIMP-2 suppresses this activity. A research study that reported data on the levels of these enzymes in serum from patients with primary and recurrent inguinal hernia was presented in an article by Smigielski and coauthors in the *European Journal of Clinical Investigation*, 2011. The authors obtained serum samples from 150 men aged 26 to 70 with primary or recurrent inguinal hernia and compared the levels of MMP-2 and TIMP-2 in this group to the levels of a group of 30 men who were in good health and did not have hernias. The reported data showed that statistically significant elevations of MMP-2 were present in men with primary or recurrent inguinal hernia; levels of MMP-2 and TIMP-2 were highest in men with recurrent hernias. This observation led the authors to suggest that recurrent hernias might be associated with increased collagen turnover; whether an increased level of collagen turnover truly contributes to the development of recurrent hernias will require additional study.

Matthews and Neumayer also cited data in support of the hypothesis that collagen structure and metalloproteinase activity are different in patients with hernias than in the general population. They further noted that the continual remodeling of the fascia and muscle layers and the collagen content of scar tissue (more Type 3 collagen and less Type 1 collagen in scars compared with normal tissue) suggest that the mechanisms of hernia recurrence are different from the mechanisms leading to primary hernia formation.

An article that provided data from a cohort of patients observed over an 18-year interval to identify inguinal hernia risk factors is by Ruhl and Everhart in the *American Journal of Epidemiology*, 2007. The original cohort included 13,452 patients. Data from 96% of the original cohort was obtained and risk factors were identified in those patients who had developed inguinal hernias; the only two significant risk factors identified were advancing age and an esophageal hiatal hernia diagnosis. Of interest was the observation that cigarette smoking was not associated with higher inguinal hernia risk, and that obesity was actually associated with a significantly decreased risk. Conditions that might contribute to increased intraabdominal pressure, such as constipation and chronic obstructive pulmonary disease, were also not associated with an increased inguinal hernia risk.

Matthews and Neumayer also provided a brief review of potential risk factors that might predispose patients to developing inguinal hernia, and noted that, historically (especially in the lay press), the factors associated with inguinal hernia have included blows to the abdomen, rough rides on horses or in carriages, excessive straining, and hard physical work. The authors emphasized that,
in theory at least, the shutter mechanism of the muscle and fascial layers surrounding the inguinal ring and the medial area of the inguinal canal should protect against hernia formation from excess activity or force transfer to the abdomen. They further noted an additional theoretic risk factor of acutely increased intraabdominal pressure; however, acute, short-lived increases in intraabdominal pressure should be offset by the same shutter mechanism. Chronic increases in intraabdominal pressure, such as what is encountered in pregnancy and in patients on peritoneal dialysis or with ascites, could increase the strain on the abdominal wall and precipitate clinically overt herniation in the umbilical or inguinal areas where small, asymptomatic hernial sacs were preexisting.

Cigarette smoking and chronic obstructive pulmonary disease (COPD) have been mentioned as acquired conditions that can predispose patients to inguinal hernia. The authors reviewed data indicating that inguinal hernia risk is the same for smokers and nonsmokers, but that the risk of hernia development is increased in patients with COPD—it is important to note that this observation contrasts with the data reported by Ruhl and Everhart.9

Dr. Fitzgibbons’ Pearl No. 1
There is minimal evidence that vigorous abdominal wall activity is an independent risk factor for abdominal wall hernia development, despite the overwhelming opinion of the contrary in lay literature.

Gender Differences in Clinical Characteristics of Inguinal Hernia

The review by Fitzgibbons and Forse9 provided perspective on gender-based differences in the clinical characteristics of groin hernia. The authors noted that while, overall, hernia risk is much higher in men than women, women are more likely to undergo urgent repair; many of these urgent repairs are for complicated femoral hernias. The authors also emphasized that a woman with a bulge noted in the groin will most often have an indirect hernia.

Differences in the type of inguinal hernia and the clinical presentation of the hernia depending on the gender of the patient were analyzed in a report by Koch and coauthors10 in the British Journal of Surgery, 2005. This report examined data from a prospectively maintained hernia database (the Swedish Hernia Registry). Nearly 7,000 hernia operations were conducted in women during a 10-year interval ending in 2003, and this patient group was the focus of the study. Data analysis disclosed that women were three times more likely to have an emergency operation for hernia complications than men (emergency operations occurred in 16% of women patients compared with 5% in men). The risk of intestinal resection was also significantly elevated in women compared with men who underwent emergency hernia procedures. Of interest was the observation that the Lichtenstein tension-free prosthetic patch operation for inguinal hernias and the Shouldice tissue-based repair were associated with the highest risk of reoperation in women; the procedures associated with the lowest recurrence risks were the transabdominal and total extraperitoneal laparoscopic repairs. Nearly half of the women who required hernia reoperation were discovered to have femoral hernias, rather than a recurrence of a typical inguinal hernia. The authors speculated that differences in the anatomy of the pelvis and groin as well as femoral hernias missed at the time of the primary operation represent the most likely reasons for these findings at reoperation. Also contributing to the increased reoperation rate in women were operations that did not adequately visualize the femoral canal—because the entire myopectineal orifice is visualized during typical laparoscopic hernia repair, it may, at least partially, explain the superior results of these procedures in the women whose outcomes were analyzed in this report.

Important Events in the History of Groin Hernia Surgery

Matthews and Neumayer7 next provided a brief review of important historical events in the development of modern approaches to inguinal hernia surgery, and reminded us that the use of trusses and bandages to accomplish and maintain hernia reduction dates from 1500 BC. The writings of Hippocrates, Celsus, and Galen focused on the anatomy of the abdominal wall. These scholars postulated that hernias occurred because of a tearing injury to various abdominal wall layers, and the term “rupture” was applied
to “hernia”; this term persists in lay parlance today. In addition, Celsus introduced the use of transillumination to differentiate hernial sacs from hydroceles.

The surgical treatment of hernia lay relatively dormant until the 14th century, when several surgeons introduced procedures for managing life-threatening complications, such as incarceration and intestinal necrosis. Over the next 400 years, leading anatomists such as Littre, Cooper, Gimbernat, and Hesselbach defined the anatomy of the inguinal region; this progress is the focus of an article by Read, and is supplied as a full-text reprint accompanying some formats of SRGS. According to Read, Cooper was primarily interested in developing a safe and useful approach to the femoral vessels for the purpose of ligating femoral aneurysm; he was also interested in an approach that would provide access to the inferior epigastric vessels, so that postoperative hematoma risk would be reduced.

Cooper described the preperitoneal space between the peritoneum and the anterior musculo-fascial layers, a region that is now termed the myopectineal orifice: this space extends from the area of the external iliac arteries medially to the space of Retzius in the retropubic area, and contains the areas of fascial weakness that cause indirect, direct, and femoral hernias to become clinically apparent. Read emphasized that entering the preperitoneal space through the weakened transversalis fascia permits the placement of a prosthetic patch to cover the entire myopectineal orifice. The prosthesis can be secured by the pressure of the peritoneal membrane against the dorsal surface of the musculo-fascial layers of the inguinal canal. Entry into this space is a critical component of treating femoral hernias, and this aspect of hernia repair will be discussed in greater detail in a subsequent section of this issue. Read concluded by emphasizing the advantages of

Figure 1
Anterior view of the anatomy of the groin. Reproduced from Fitzgibbons and Forse with permission.

![Image](image-url)
the preperitoneal approach for difficult hernias (recurrent hernias, large scrotal hernias, and sliding hernias) and noted that the current laparoscopic hernia repair techniques take advantage of access using the preperitoneal space.

**Anatomic Features of the Inguinal Region**

Fitzgibbons and Forse¹ provided clear illustrations of the anatomy of the groin. An illustration of this area as viewed via a conventional groin incision is reproduced as Figure 1. A dorsal view of the myopectineal orifice as it would be seen during a laparoscopic groin hernia repair is reproduced as Figure 2.

The anatomy of the groin was also discussed in the review article by Matthews and Neumayer.⁷ They noted that the floor of the inguinal canal is composed only of the transversalis fascia and the tendinous insertion of the transversalis muscle. The inguinal area is bordered cranially by the arch of the conjoint tendon of the transversus abdominis muscle. Medially, this space is bordered by the rectus sheath and the rectus abdominis muscle, and inferiorly, Cooper ligament forms the lower border of this space. The inguinal ligament divides the inguinal space into upper and lower halves. Laterally, the iliopsoas muscle completes the list of bordering structures. The inferior epigastric vessels divide the inguinal region into medial and lateral portions: lateral to the inferior epigastric vessels, the internal inguinal ring forms the entry point for the spermatic cord or round ligament as they traverse the space to the scrotum or labia, respectively; medial to the inferior epigastric vessels is Hesselbach triangle, the region where direct hernias protrude into the inguinal canal. As the inferior epigastric artery is traced proximally to its origin from the external iliac artery, the femoral canal (the site of femoral hernia) is encountered. This canal contains the femoral artery and vein, as well as the femoral nerve and lymphatic tissue.

Matthews and Neumayer next reviewed the anatomy of the important nerves found in the inguinal canal region. These nerves, when damaged or encased in scar tissue, can give rise to numbness and pain, which is a troublesome complication of inguinal hernia repair. The iliohypogastric, ilioinguinal, genitofemoral, and lateral femoral cutaneous nerves are found within or near the inguinal canal, and the authors provided a clear description of the anatomy of these nerves: the iliohypogastric...
nerve arises from the spinal nerves in the T12-L1 area and proceeds around the torso in the retroperitoneal space. It is most commonly located at the cranial border of the inguinal space adjacent to the conjoint tendon of the transversus abdominis muscle, and divides into anterior and lateral branches; skin sensation in the suprapubic area is provided by these branches. The ilioinguinal nerve also has its origin in the L1 region. It courses in the retroperitoneum from the spinal cord laterally around the torso to the inguinal canal area and lies adjacent to the spermatic cord or round ligament within the cremaster muscle tissue. This nerve provides sensation to the scrotum, labia, and anterolateral thigh skin, and is vulnerable to injury during opening and suture closure of the external oblique fascia.

The genitofemoral nerve arises from the L2-L3 region and divides into genital and femoral branches. The genital branch is located in the inguinal canal adjacent to the spermatic vessels within the spermatic cord. The genitofemoral nerve mediates the cremaster reflex and supplies sensation to the skin of the scrotum, mons pubis, and labia. The lateral femoral cutaneous nerve originates in the L2-L3 region, emerges lateral to the iliopsoas muscle, and provides innervation to the skin of the anterior and lateral thigh. This nerve is vulnerable to injury if laparoscopic tacks are used to secure a prosthetic patch during laparoscopic inguinal hernia repair.

The Clinical Classification of Inguinal Hernia

Matthews and Neumayer noted that several classification systems are used to subdivide the various types of inguinal hernias. As the use of clinical databases, such as the American College of Surgeons’ surgeon-specific registry, increases, the availability of a clinically valid classification system becomes more important.

The various types of classification systems, as well as a suggested comprehensive system, are discussed in an article by Zollinger in Hernia, 2004. Zollinger opened his discussion by describing the various classification schemes that have been published since the late 1950s. These systems mostly focus on whether the patient is a child or an adult, whether the hernial sac protrudes through the inguinal ring, the medial area of the dorsal inguinal floor, or both, and whether the hernia is inguinal or femoral. Currently, three classification systems are used in most frequently: the Gilbert classification system, the Nyhus/Stoppa classification system, and the system proposed by Dr. Volker Schumpelick.

The Gilbert system consists of three varieties of indirect hernias, classified as small, medium, and large. Two varieties of direct hernias were described: one variant involved complete weakness of the direct area of the inguinal canal with protrusion; the other variant involved a “diverticulum” opening in the inguinal wall of no more than 2 cm in size. A later modification of the Gilbert system, proposed by Dr. Ira Rutkow, added categories for pantaloon hernias (simultaneous direct and indirect sac) and femoral hernias.

The Nyhus/Stoppa system consists of four hernia types (and subtypes): Type 1 is an indirect hernia with a functionally intact internal ring, mostly found in infants and children; Type 2 hernias are indirect hernias with an enlarged and/or distorted internal ring type 2 hernias do not involve the direct area of the inguinal wall medial to the inferior epigastric vessels, and the sac does not descend into the scrotum. Nyhus/Stoppa Type 3 hernias are subdivided into three categories: type 3A is defined as a direct hernia that has no involvement of the internal inguinal ring; a type 3B hernia is a large, indirect hernia that encroaches on the direct area medial to the inferior epigastric vessels; type 3B includes pantaloon and sliding hernias (one wall of the sliding hernial sac includes a visceral structure such as the cecum or bladder); type 3C hernias include primary femoral hernias; type 4 hernias are classified as recurrent hernias (4A-indirect, 4B-direct, and 4C-femoral).

The Schumpelick system is mainly used in Europe and classifies hernias according to the origin of the sac (L-lateral, M-medial, and F-femoral), as well as according to defect size. A table providing a summary of the three hernia classification systems is provided by Zollinger and is reproduced as Figure 3.

In his article, Zollinger proposes an “updated traditional” classification system. This system is a comprehensive, clinical categorization that divides hernias according to anatomic location (direct, indirect, femoral, or combined) and according to hernia size. A zero category is also included in this proposed system, and is reserved for unusual inguinal hernias, such as combined indirect,
direct, and femoral, as well as massive hernias (greater than 8 cm defect) and hernias of the prevascular space. Modifier terms (recurrent, strangulated, incarcerated, etc.) can be applied to each category: the complete list of modifier terms is supplied as a table in the original article and readers are encouraged to review it. With the application of these terms, all forms of inguinal hernias can be accurately described.

**Dr. Fitzgibbons’ Pearl No. 2**

The three classic groin hernias are direct (commonly referred to as “medial” outside of the United States), indirect (or “lateral”) and femoral. The nomenclature can be confusing because some studies use the words “inguinal” and “groin” interchangeably.

An illustration of each of the hernia types in Zollinger’s system is included as Figure 4. Zollinger emphasizes that this proposed classification system contains no overlapping categories and is all-inclusive.

**Diagnosing Inguinal Hernia**

Most patients with inguinal hernia present with complaints of a bulge in the groin that is sometimes associated with pain in the area of the bulge. Diagnosing hernia can be difficult in obese patients and in patients with femoral hernias; evaluating inguinal pain in such patients might require ultrasonographic examination or axial imaging using computerized tomography (CT) or magnetic resonance imaging (MRI) to confirm the presence or absence of a hernia. Occult femoral or inguinal hernia needs to be excluded in patients presenting with signs and symptoms of intestinal obstruction without a prior history of abdominal operation; most symptomatic occult femoral hernias occur in elderly women. For patients who present with acute or chronic incarceration of an inguinal hernia associated with new onset of pain and/or signs of intestinal obstruction, diagnostic efforts should focus on detecting intestinal necrosis.

**Practice Guidelines for Inguinal Hernia**

The Society for Surgery of the Alimentary Tract (SSAT) published guidelines for the management of inguinal hernia\(^1\) that can be found in the *Journal of Gastrointestinal Surgery*, 2007. The guidelines encourage the elective repair of inguinal hernias in patients who are deemed fit for operation and who are symptomatic or have chronic hernia incarceration because the risk of a complication requiring urgent operation is increased in this patient group. The guidelines also suggest that all patients diagnosed with femoral hernias should have elective repair. The use of trusses or bandages to maintain hernia reduction is discouraged, except in patients who are deemed unfit for operation; truss/bandage use may lead to chronic groin scarring, which makes elective hernia repair difficult. The guidelines note that certain minimally symptomatic hernias may be followed clinically, and that operations on these hernias can be performed when they become significantly larger or symptomatic. This topic is discussed in detail in the following section of the overview.
According to the SSAT guidelines, options for elective repair of groin hernias include open tissue-based repair, various open-repair methods that use prosthetic patches and/or plugs, and laparoscopic prosthetic patch repairs. The guidelines note that tissue-based repairs are used currently for emergency hernia repair, where the operative field is potentially contaminated from intestinal or omental necrosis.

Most elective hernia repairs, except those tissue-based repairs done in specialized hernia centers using the Shouldice technique, are completed using one of the prosthetic patch repair methods. The open operations can usually be performed as outpatient procedures using local, regional, or general anesthesia; laparoscopic repairs require general anesthesia. Recurrence rates for all types of repairs are in the range of 2%–5%, and none of the prosthetic patch repair methods done using open or laparoscopic approaches yield superior results in terms of recurrence. Chronic pain requiring treatment occurs in approximately 5% of patients observed for more than three years; this complication may require multimodality management and, occasionally, reoperation.

The SSAT guidelines conclude by stating that elective open hernia repair is within the expected skill set of surgeons who have completed a typical five-year residency training program in surgery and have been certified (or are eligible for certification) by the American Board of Surgery or another recognized certification agency. Training and experience in laparoscopic surgery is recommended for surgeons who aspire to perform laparoscopic hernia repair.

Additional practice guidelines for managing groin hernia in adults have been promulgated by the European Hernia Society (EHS) and were presented in an article by Simons and coauthors in *Hernia*, 2009. In addition to the practice guideline recommendations, this article provided a detailed metaanalysis of data supporting the recommendations; due to the value of this extensive examination of important published data, this article is included as a full-text reprint accompanying some formats of *SRGS*; in addition, the EHS guideline recommendations are summarized in an algorithm reproduced as Figure 5.

Simon and coauthors agree with the previously discussed SSAT guidelines, which state that symptomatic hernias in patients 18 years of age or older should be repaired using one of the open prosthetic patch repairs or a laparoscopic prosthetic patch repair; the EHS guidelines suggest that recurrence rates for laparoscopic repair are
lower with the total extraperitoneal approach and that prostheses 10 x 15 cm or larger should be used. Simons and coauthors recommend that femoral hernias be excluded in all female patients and that laparoscopic repair is preferable for women with groin hernias. According to the EHS guidelines, most hernia repairs in patients with an ASA class status of I, II, or III can be performed as outpatient procedures. Prophylactic antibiotics are not recommended for routine hernia repair procedures.

The EHS guidelines also offer recommendations for managing postoperative complications. For hernia recurrence after an anterior open operation, a posterior preperitoneal approach using a laparoscopic technique is favored; for recurrence after a laparoscopic repair, open tension-free prosthetic patch repair is preferred; the Shouldice repair technique is the only tissue-based repair recommended. The EHS guidelines state that chronic pain may be encountered in 5%–10% of patients observed for more than five years, and that excising the ilioinguinal nerve does not reduce the risk of chronic pain. Careful identification and protection of the three nerves that traverse the inguinal canal is an advised technique and the guidelines noted that this practice is associated with reduced chronic postoperative pain risk. For patients with severe chronic inguinal pain, the authors recommend multidisciplinary pain management, including consulting with pain management specialists. The EHS guidelines recommend watchful waiting in adult patients with minimally symptomatic groin hernias, especially direct hernias with large hernial sac necks.

The final set of guidelines discussed resulted from an analysis of a very large hernia database from Denmark. This analysis and the recommendations derived from the analysis are reported in an article by Rosenberg and coauthors in the Danish Medical Bulletin, 2011. The recommendations within this article are in general agreement with the SSAT and EHS guidelines reviewed previously; however, the Danish recommendations differ slightly from the previously discussed guidelines with regard to the management of groin hernia in women: the data from the database analysis suggested that all hernias discovered in women be repaired, and that laparoscopic prosthetic patch repair is the procedure of choice.

**Figure 5** European Hernia Society Clinical Practice Guideline algorithm. Reproduced from Simons* with permission.
Minimally Symptomatic Inguinal Hernia: Operation vs. Watchful Waiting

Deferring operations for male adult patients with known groin hernias is an acceptable option if the patient has a small or medium-sized hernia with minimal symptoms; in this section of the overview, we will discuss data supporting this approach.

Obviously, deferring an operation should not impair quality of life, ability to work productively, and/or family functioning. Additionally, it should not place the patient at any significant risk for hernia-related complications; available data suggests an increased risk of groin hernia complications as patients age. Likewise, there should be extensive patient education about the types of symptoms that would indicate the need for operation as well as the need for careful follow-up. Patient education materials relevant to this area of surgical practice are available from the American College of Surgeons Division of Education Patient Education Unit at [www.facs.org/patienteducation/patient-order.html](http://www.facs.org/patienteducation/patient-order.html).

Fitzgibbons and coauthors\textsuperscript{16} reported the results of a randomized prospective trial of more than 700 patients with minimally symptomatic groin hernias (defined as hernias that were either visible and/or palpable, or hernias diagnosed by the presence of a palpable impulse on coughing) in the *Journal of the American Medical Association*, 2006. The trial was conducted in four medical centers, and the enrolled patients were evenly divided into two groups: immediate elective operation using an open, tension-free prosthetic patch repair or watchful waiting. All patients were observed for at least two years and, for a significant proportion of the patients enrolled, follow-up of more than four years was available. Patients were assessed with the SF-36 quality of life assessment instrument with particular attention paid to the pain and physical function components of the assessment. Forty percent of the patients had a hernia diagnosed by the presence of a palpable impulse only. Patients assigned to the watchful waiting group were examined at six months after enrollment and annually thereafter. Patients in the elective operation group had follow-ups at three months, six months, and then annually. The authors noted that the main reason for recommending operation for a groin hernia in adult men is to remove the risk of a hernia-related complication that might require an emergency operation. They also stressed that data supporting a high risk of this complication in minimally symptomatic hernia is scarce: the authors cited data from one study of patients managed before the availability of safe operations for hernia repair and a report from Colombia; both studies estimated that the risk of a hernia-related complication during long-term follow-up was approximately 3 per 1000 patients. Analysis of the data in the article by Fitzgibbons and colleagues revealed that 23% of patients assigned to the watchful waiting group crossed over into the operation group, while 17% patients assigned to the operation group decided against having the procedure. When the data were examined on both the intent-to-treat and an actual-treatment-received basis, there was no significant difference in quality of life scores or physical functioning. Two patients (0.3%) developed hernia-related complications requiring urgent operation: one of these occurred less than one year after enrollment and one occurred four years after enrollment. The most common reason for patients in the watchful waiting group to cross over into the surgical repair group was increased pain: after surgical repair, this group of patients experienced marked improvement in pain levels. Patients who refused an operation after being assigned to the operation group were generally less healthy than patients who underwent surgical repair.

The authors documented small complication risks after operation; for example, long-term pain that impacted quality of life was observed in less than 2% of patients over a two-year follow-up. They also documented the low risk of serious hernia-related complications in patients managed without operation. Lastly, the authors cited data from a large database that confirmed the clustering of emergency hernia complications in elderly patients and a low mortality (2.2%) after urgent repair. Fitzgibbons and coauthors concluded that watchful waiting is a safe and effective management option for minimally symptomatic men with groin hernia, and that patients with groin pain and sensory disturbances in the distributions of the inguinal canal nerves might be less desirable candidates for watchful waiting.
Data from another, albeit much smaller, randomized, prospective trial was reported in an article by O’Dwyer and coauthors17 in *Annals of Surgery*, 2006; this report presented data on 160 patients with a visible and palpable inguinal hernia equally divided into observation and operation groups. Patients assigned to the operation group had a tension-free repair. All patients were evaluated at six months after enrollment and annually thereafter; standard SF-36 quality of life scores were administered during follow-up. In contrast to the previously discussed randomized controlled trial, three patients (3.8%) in the observation group required urgent hernia repair for a hernia-related complication: one of these patients died from a postoperative stroke, and another patient suffered a postoperative myocardial infarction. This difference in hernia-related complications and severe postoperative complications compared with the trial reported by Fitzgibbons and colleagues16 could be, in part, because of the older patient population reported in the O’Dwyer study. The mean age of patients enrolled in the Fitzgibbons study was 58, while the mean age of patients in the O’Dwyer study was 72. The trial reported by O’Dwyer disclosed that there was no significant difference in pain scores and quality of life scores at any point of comparison of the two groups during the trial. Of interest is the observation that during follow-up, the patients assigned to the operation group thought that their health status improved; patients assigned to the watchful waiting group said that their health status had declined. The investigators also conducted a cost analysis that, not unexpectedly, showed that increased cost was associated with assignment to the operation group. O’Dwyer and coauthors concluded that, while there was a significant risk for the need for emergency operation in this older group, deferral of operation did not result in increased pain or significantly decreased quality of life overall. Long-term pain was no different between patients operated on or those assigned to watchful waiting; however, as noted above, patients assigned to operation perceived their health status as better than that perceived by patients in the watchful waiting group. The authors acknowledged that longer follow-up is needed to confirm the safety of watchful waiting as well as the benefits of operation.

Long-term follow-up of the patients enrolled in the above randomized prospective trial reported by O’Dwyer and coauthors is discussed in an article by Chung and coauthors18 in the *British Journal of Surgery*, 2011; this article presents data from the 61 surviving patients initially randomized to watchful waiting. As mentioned earlier, the mean age of patients in the O’Dwyer study was 72, and all hernias were visible and/or palpable: no patient was diagnosed by a palpable impulse only. Chung and coauthors noted that 16% of patients crossed over to the operation group two years after enrollment. After five years of follow-up, however, more than 70% of patients had crossed over. The authors concluded that most patients will choose operation eventually and that older patients with a higher risk of complications would probably benefit from earlier operation, when operative risk was lower.

Long-term follow-up data is also available for patients enrolled in the randomized prospective trial by Fitzgibbons and coauthors16. These results were reported in a paper presented to a plenary session of the 2013 meeting of the American Surgical Association.19 The data analysis showed that there was a 68% crossover rate for patients originally randomized to the watchful waiting group over a follow-up interval of more than seven years. The incidence of hernia “accidents” (incarceration, strangulation) remained low. In the discussion that accompanied the article discussants noted that long-term data was missing on approximately 30% of patients originally enrolled. Also noted was the fact that follow-up data on patients who crossed over to operation were not reported. Because of this, a completely accurate comparison of the long-term results of watchful waiting vs. immediate operation could not made.

A cost-effectiveness analysis was conducted using data from the patients enrolled in the randomized prospective trial reported by Fitzgibbons and coauthors.16 Data from this analysis are reported in an article by Stroupe and coauthors20 in the *American Journal of Surgery*, 2006; these authors calculated health care costs and cost per quality-adjusted life year gained for 641 patients from the original trial. The patients were roughly equally divided between patients assigned to operation vs. watchful waiting; the results of this analysis agree with O’Dwyer and associates’
findings: the operation group incurred higher costs than did the watchful waiting group, with costs averaging about $1,800 over the two years after enrollment. The cost per quality-adjusted life year gained was more than $59,000, and the authors estimated the probability that operation would be cost effective at the $50,000 level to be 40% (this level is agreed to be the level acceptable for public funding of a health care intervention). The authors noted that the cost effectiveness of hernia repair procedures is likely to improve over time as more and more patients cross over from the watchful waiting group to the operation group.

An analysis that also uses patient data from Fitzgibbons’ randomized prospective trial attempted to delineate the impact of watchful waiting on family functioning; this analysis was reported in an article by Gibbs and coauthors in the Journal of the American College of Surgeons, 2007. The authors asked participating patients to identify a family member who would likely be their primary caregiver. This family member was then asked to respond to questions about patient function and the need for family time to assist the patient at each study follow-up interval: data from 543 patients were analyzed. At each point in the follow-up interval there were small, but statistically significant, differences in responses to questions about concerns regarding the need to dedicate family time to assist the patient; these differences favored operation over watchful waiting. The small magnitude of the response differences raises the question of whether the observed changes, though statistically significant, were actually clinically significant. Gibbs and coauthors concluded that the impact on family function favors operation over watchful waiting, but that this overall impact is small.

A consistent observation from randomized trials of watchful waiting vs. operation for groin hernia in men has been that roughly 25% of patients cross over from the watchful waiting group to the operation group over the early course of follow-up. A study seeking to determine whether short-term surgical outcomes differ in patients having immediate vs. delayed hernia repair is by Thompson and coauthors in the American Journal of Surgery, 2008. Once again, the reported data were drawn from information recorded during the previously reviewed randomized prospective trial reported by Fitzgibbons and coauthors. Outcomes of immediate operation in 288 patients were compared with outcomes in 68 patients undergoing delayed (more than six months after enrollment) operation; the authors found that operative morbidity, postoperative pain, recovery time, and satisfaction with the outcomes were similar between the two groups, and concluded that delaying an operation for a groin hernia until symptoms occur does not result in worse operative outcomes.

Sarosi and coauthors also identified characteristics of patients who cross over from watchful waiting to operation: their article, published in Annals of Surgery, 2011, theorized that if risk factors could be recorded that would help identify patients who might benefit from earlier operation. The authors analyzed data from patients assigned to watchful waiting who later crossed over to the operation group and assessed the progression of patients’ pain symptoms during normal activity and during strenuous activity; it was found that patients were progressively more likely to cross over as pain levels increased. Other features associated with both increasing pain and increasing risk of crossover were chronic constipation, married patient status, healthier ASA class (ASA class 1 was more likely to cross over), and symptomatic prostatism. Sarosi and coauthors concluded that, when watchful waiting is contemplated for a patient with a minimally symptomatic hernia, identifying these features can assist the clinician in recommending early operation to the patient because of the high risk of crossover and to better avoid pain progression.

Editorial Comment

The data from the prospective trials discussed above provide valuable advice and guidance for surgeons advising patients about the repair of minimally symptomatic groin hernias.

Key take home messages include:

- Hernia repair, including the complete evaluation and repair of femoral hernias, is indicated in women, regardless of symptoms; the laparoscopic approach is preferred.
- Young, healthy men (especially those with hernias diagnosed by the presence of a palpable inguinal impulse on coughing only) are good
candidates for watchful waiting, as long as they do not have significant hernia-related pain, chronic constipation, or prostatism.

- Patients with visible and/or palpable groin hernias and who are older than 60 will probably eventually opt for hernia repair. Good risk patients who are physically active are good candidates for hernia repair. Careful patient counselling is important.
- Early repair is a worthwhile consideration in patients who have chronic comorbid conditions that will likely progress over time and result in higher operative risk.
- The risk of an acute hernia emergency is small, but not negligible; this risk increases with age and emergency presentations cluster in older individuals—which is another reason early repair may be preferable for patients whose hernias are initially diagnosed after 60.

Emergency Management of Inguinal Hernia Complications

The complications of groin hernia leading to emergency and urgent operations include incarceration of the hernia or incarceration with intestinal obstruction and/or necrosis. These complications are frequently encountered in elderly patients with multiple serious comorbid conditions. Operative mortality in various reports ranges from 2.5% to 10% when emergency operation is needed; mortality in patients undergoing emergency operations for groin hernias is driven, mainly, by preexisting comorbid factors.

Although practice guidelines suggest that a trial attempt at reducing an acutely incarcerated hernia is acceptable, the clinical detection of intestinal ischemia in an elderly, high-risk patient is sufficiently challenging that experienced clinicians often prefer to use clinical examination and axial imaging to confirm the presence of intestinal obstruction and to seek evidence of intestinal ischemia (continuous pain, tenderness in the area of the hernia mass, edema of the bowel wall, and absence of visible perfusion on imaging). If there is a suspicion of intestinal obstruction and/or ischemia, emergency operation is indicated; tissue-based hernia repair has been the standard approach for patients requiring emergency operation because of the fear of infecting the prosthetic material used for repair if bowel ischemia is present.

A review of emergency hernia repair data was presented by Abi-Haidar and coauthors in the Journal of the American College of Surgeons, 2011. The authors retrospectively reviewed medical record data for more than 1,000 patients undergoing hernia repair in a single Veterans Administration medical center over an eight-year interval. Outcomes in 971 patients who underwent elective repair were compared with outcomes in 63 patients who underwent emergency repair. Analysis of the demographic characteristics of each group disclosed that patients presenting with an acute complication were more likely to be older (median age 74 compared to 64 for patients undergoing elective operation). The patients undergoing emergency operations were more likely to have hernias that had extended into the scrotum, femoral hernias, and recurrent hernias. Of interest was their observations that more than half the patients presenting with an acute complication had not been diagnosed with a hernia before the complication. In this group, 75% of the patients did not know they had a hernia, and the remainder knew they had hernia symptoms, but had deferred treatment. Patients who knew they had a hernia often experienced delays in seeking medical attention or delays by primary care providers in recommending operation. The mean time from diagnosis to emergency operation was more than two years in the group with an acute complication of groin hernia. Patients who underwent an emergency operation were more likely to experience a complication (hematomas and surgical site infections [SSIs] were the most common complication types): 27% of the emergency repair group had a complication, compared with 15% of the elective repair group. In addition, mortality for the emergency repair group was 1.7%, compared with 0.1% in the elective surgery group; one person who underwent emergency hernia repair died.
The authors concluded that emergency hernia repair is relatively safe, but that the high proportion of patients with undiagnosed hernias at the time of emergency presentation is alarming. They also noted that elective hernia repair in elderly patients is very safe, and recommended that groin hernias in elderly patients (who are at low operative risk) should be electively repaired, especially if the hernia extends into the scrotum or if there is a femoral hernia. Finally, the authors advised that the education of primary care physicians be undertaken to help increase hernia awareness and the frequency of hernia examinations.

As noted previously, the traditional approach in an emergency hernia operation where intestinal ischemia has occurred is a tissue-based repair: usually a Bassini repair, where the conjoint tendon is sutured to the inguinal ligament after reduction of the sac contents and high ligation of the sac, or the proximal remnant of a divided sac if the sac is large and extends into the scrotum. Because of the high hernia recurrence rate associated with emergency tissue-based repairs, interest in applying tension-free prosthetic patch repair approaches in this clinical situation has increased; an article focusing on this topic is by Elsebae and coauthors25 in the International Journal of Surgery, 2008. The authors presented a randomized trial comparing tension-free prosthetic patch repairs of strangulated inguinal hernias with conventional Bassini repairs. The authors randomized 54 patients with incarcerated hernia and obvious intestinal ischemia, but excluded patients requiring intestinal resection or patients with obvious peritonitis or severe inflammation of the hernial sac. Twenty-seven patients were assigned to each group depending on the patient’s registration number. In a follow-up interval of two years, the authors found no difference in early postoperative complications when the groups were compared; only one instance of surgical wound infection occurred and no instances of prosthetic patch infection occurred.

Although the outcomes reported in this study are impressive, the trial may not have adequate statistical power to document differences between groups. The fact that patients with irreversible intestinal ischemia were excluded means that this approach cannot be recommended for these patients. Also, based on the information reported, it is not possible to determine whether the included patients actually had a strangulated hernia or an acutely incarcerated hernia. For these reasons, the results of this study cannot be used to support a wider application of tension-free prosthetic patch repairs in patients with potential hernia strangulation.

An article by Deeba and coauthors26 focused on the use of laparoscopic repair for incarcerated and strangulated groin hernias in the Journal of the Society of Laparoendoscopic Surgeons, 2009; this article is a systematic review of the literature. The examined data disclosed that results of the transabdominal laparoscopic approach and the total extraperitoneal laparoscopic approach to incarcerated inguinal hernia seem to produce results similar to elective hernia repairs using these techniques. All laparoscopic repairs require the insertion of prosthetic patch, so the risk of prosthesis infection has to be considered. The articles reviewed dealt, for the most part, with the management of incarcerated hernia. Intestinal resection was performed only 17 times in 328 patients, supporting the interpretation that true irreversible intestinal ischemia was not a main focus of the articles reviewed. Only two cases of prosthesis infection were reported and both were salvaged without removal of the prosthesis. Whether these infections occurred in patients requiring intestinal resection is not reported. If all prosthesis infections occurred in patients with intestinal resection, the infection rate for laparoscopic repair of strangulated hernia could be as high as 18%. Deeba and coauthors concluded that the laparoscopic repair of incarcerated inguinal hernias is feasible and may be as safe as elective laparoscopic repair; however, the laparoscopic repair of strangulated hernias cannot be recommended based on the data available. The authors also reported that additional data from prospective multicenter trials are needed to make a strong recommendation for this repair approach.

A study comparing tension-free prosthetic patch repair to prosthetic patch repair using the preperitoneal open exposure technique (Nyhus technique) is by Karatepe and coauthors27 in the International Journal of Surgery, 2008. The authors reported a small, randomized series of patients with incarcerated or strangulated hernia. Strangulation was defined as an inability to reduce the hernia manually at the beginning of the operation. Forty patients were randomized to two groups. Nineteen patients had the preperitoneal approach and 21 patients had open tension-free...
prosthetic patch repair. Intestinal resection was necessary in six patients in each group. The authors noted that four of the 21 patients having the open tension-free repair required a second incision for management of the incarceration or strangulation and these patients experienced significantly more (albeit mostly minor) perioperative complications. No instances of prosthesis infection were reported. The authors concluded that the open preperitoneal approach was associated with better short-term outcomes than the open tension-free repair. Although the data are clear in this report, the small numbers of patients and the confusing definition of strangulation make these results of questionable value in developing a recommendation for managing strangulated inguinal hernia.

**Editorial Comment**

For the elective repair of isolated and indirect inguinal hernias in women, tissue-based repairs are feasible and acceptable because the round ligament can be excised and the internal ring completely closed. Based on the available data, tissue repair should also be the first-line approach to strangulated inguinal hernia where intestinal resection has been done and/or where clinically evident peritonitis is present.

Although the literature on repairing ventral/incisional hernias in high-risk operative fields has documented the feasibility of biologic prosthesis use, literature concerning the use of these materials for inguinal hernia is small and, on the whole, inconclusive. Biologic prostheses may have usefulness for the repair of inguinal hernias where the risk of infection is high.

A small randomized prospective trial of the use of biologic prosthetic patches compared with standard Lichtenstein prosthetic patch repair is by Ansaloni and co-authors in the *American Journal of Surgery*, 2009. This study randomized 35 patients into the two treatment groups. The biologic prosthesis was well tolerated with no significant difference in overall outcomes at follow-up of three months. Patients with biologic prostheses had less pain on movement and less pain with coughing than patients with conventional prosthetic patches. The authors stressed that the trial was not powered sufficiently enough to assess recurrence; only one recurrence was seen in the standard prosthetic patch group. The authors concluded that biologic prosthesis is a feasible alternative in patients requiring inguinal hernia repair.

**Elective Surgical Management of Inguinal Hernia**

The features of elective operations have evolved over the long history of surgical management of groin hernia. The objective of new techniques introduced during the second half of the 20th century and onward has shifted from minimizing recurrence (recurrence rates for current repairs are consistently reported at levels less than 5% over follow-up intervals of more than five years) to the prevention of chronic complications of groin hernia repair, such as chronic pain and testicular dysfunction.

One significant development in the management of groin hernia in North America and in Europe has been the emergence of hernia centers that specialize in the care of patients with groin hernia. These centers offer mostly outpatient hernia care, and these specialized clinics report the lowest hernia recurrence rates. As we will elucidate later in this section of the overview, tissue-based repairs of groin hernias have given way to open and laparoscopic prosthetic patch repairs because most general surgeons have found that recurrence rates for tissue-based repairs are too high and the tissue-based repair associated with the lowest reported recurrence rates (Shouldice repair) is difficult to learn. Furthermore, the results reported from specialized centers using the Shouldice repair technique could not be duplicated in most general surgery practices.
Hernial Sac Management in Groin Hernia Repair

One ubiquitous feature of all groin hernia operations is high ligation, division, or return of the intact hernial sac to the intraperitoneal space. Experience with managing inguinal hernia in children has emphasized the importance of high ligation or obliteration of the indirect hernial sac. Most operations for direct hernia include a maneuver for excising or reducing the size of the hernial sac with imbricating purse-string sutures. In large scrotal hernias, the sac is divided and the proximal segment sutured closed to prevent damage to the spermatic cord vessels, nerves, and vas deferens. In sliding hernias, the portion of the sac where the visceral structure is a part of the sac wall is divided from the remainder of the sac and the proximal opening in the sac is closed prior to returning the sac and the contained visceral structure to the peritoneal cavity.

The effect of the chosen sac management technique on groin hernia recurrence risk is the topic of an article by Stylianidis and coauthors in the *British Journal of Surgery*, 2010. The authors queried the Swedish Hernia Register and obtained data for hernia recurrence based on surgeon-reported technical features of each operation. The analysis included more than 48,000 repairs of indirect inguinal hernias. The sac was ligated and excised in 49% of repairs, invaginated without ligation in 38% of repairs, and divided in 13% of repairs. The analysis disclosed that the recurrence rate for patients having invagination of the sac was 2.7%, while the risks of recurrence for ligation and excision of the sac and division of the sac were 1.7% and 1.7%, respectively. The authors reported that the combination of a tension-free prosthetic patch repair with ligation/excision of the hernial sac yielded a five-year risk of recurrence of the hernia of 1%. The authors concluded that sac invagination exposes patients to a significantly increased risk of recurrence; they also noted that this study was not designed to seek out other postoperative complications, such as chronic pain. Furthermore, no techniques that specifically occlude the internal inguinal ring, such as plug and patch repair or use of the Prolene hernia system, were used in the operations reviewed.

Open Tissue-Based Herniorrhaphy

The collective review by Matthews and Neumayer includes a section which discusses each of the tissue-based repair techniques. The authors noted that two of the classic techniques (Marcy and Bassini) were initially reported in the late 19th century. The Marcy repair is especially designed for indirect hernias; the key element of the Marcy repair, which is high ligation of the indirect hernial sac, is also the central technical feature of the management of indirect hernias in children. After separation of the hernial sac from the cremaster muscle fibers, high ligation of the sac is performed with return of the ligated stump of the sac into the peritoneal space; the internal ring is then tightened with nonabsorbable sutures placed at the medial border of the internal ring. Care is taken not to compress the spermatic cord vessels with the tightening sutures. Matthews and Neumayer emphasized that the Marcy repair is well-suited for the management of indirect inguinal hernias in women (if coexisting femoral hernia is excluded) because the round ligament can be divided at the level of the internal ring and the internal ring can be completely closed.

The other inguinal hernia technique introduced in the late 19th century was the Bassini repair. This repair is performed via a groin incision parallel to the inguinal ligament. The spermatic cord is isolated and all cord structures are excised except the vas deferens, the testicular blood vessels, and the ilioinguinal and genitofemoral nerves. The transversalis fascia is then opened from medial to lateral in the inguinal canal and the femoral canal is examined for the presence of femoral hernia. Cooper ligament and the iliopubic tract are exposed. The superior tissue mass, which includes the conjoint tendon and transversus abdominis muscle superiorly and the lateral border of the rectus fascia medially, is sutured to the inguinal ligament with non-absorbable sutures. Bassini’s original series with nearly five-year follow-up reported recurrence rates of 2.3% and a wound infection rate of 5%. Matthews and Neumayer emphasized that wound infection rates are lower in modern published series, though reproducing the recurrence rate reported by Bassini has not regularly occurred. Matthews and Neumayer opined that many modern surgeons do not assiduously follow the technical
points of this operation as it was originally described, and this may be one cause of the difficulty in reproducing Bassini’s results. The Bassini repair remains the method of choice for managing strangulated hernias in high-risk wounds where prosthetic patch placement would be risky.

The Halsted hernia repair was reported in the early decades of the 20th century and is a modification of the Bassini repair. Halsted included the superior edge of the external oblique muscle in the tissue sutured to the inguinal ligament. The inferior leaflet of the external oblique was then sutured to the ventral surface of the superior leaflet. The spermatic cord was transplanted into the subcutaneous space. The repair was associated with high rates of testicular ischemia and hernia recurrence. The Andrews modification of the Halsted repair protected the spermatic cord with the inferior leaflet of the external oblique and this addition reduced the rate of testicular ischemia, but not the unacceptable hernia recurrence rate.

Matthews and Neumayer noted that Chester McVay proposed a modification of the tissue-based hernia repair in 1939. This modification was based on anatomic studies conducted by McVay that led to his conclusion that the caudal insertion of the transversalis fascia was the ligamentous tissue in the preperitoneal space along the cranial border of the superior pubic ramus (Cooper ligament); he therefore concluded that a proper anatomic repair would be one that sutured the conjoint tendon and superior leaflet of the transversalis fascia to this ligamentous tissue. Extensive relaxing incisions in the anterior rectus sheath and the transversus abdominis muscle fascia were necessary to accomplish this closure. Laterally, a transition stitch from Cooper ligament to the lateral inguinal ligament both obliterated the femoral canal and created a new internal inguinal ring. The excessive tension on the tissue required for this repair exposes patients to a high recurrence risk. This repair is helpful, however, when femoral hernias containing necrotic intestine are encountered and prosthetic patch placement would expose the patient to the risk of infection.

Dr. Earl Shouldice, a Canadian surgeon, is credited with developing the modern groin hernia repair technique associated with the lowest reported recurrence rate of any tissue-based repair. He also pioneered the specialized hernia clinic. The Shouldice repair is a modification of the Bassini technique that uses a multi-layered overlapping closure of the inguinal floor using continuous sutures. The initial exposure includes mobilization of the spermatic cord and protection of the nerves in the inguinal canal. After high ligation of the sac, the inguinal floor is repaired in layers with a continuous monofilament suture beginning at the medial border of the canal and suturing the inferior portion of the transversalis fascia to the lateral border of the rectus muscle. The suture continues to close the transversalis fascia laterally to the internal ring. The suture is then reversed and the upper portion of the transversalis fascia is sutured to the inguinal ligament. When the medial border is reached, a new suture is begun that sutures the conjoint tendon to the inguinal ligament. The operation concludes with closure of the external oblique muscle and fascia over the cord. The Shouldice repair technique is challenging to learn to perform successfully for most surgeons. While reports from the Shouldice Hernia Center have documented recurrence rates at least as good as those reported with any other repair method, the technique is difficult to master, and early results may not be as good as the prosthesis-based repairs that are discussed in a subsequent section of the overview.

Outcomes Comparison of Tissue-Based Approaches to Inguinal Hernia Repair

A Cochrane Collaboration metaanalysis of the literature comparing open tissue-based hernia repairs is by Amato and coauthors in the Cochrane Collaboration Systematic Reviews, 2009. These authors reviewed eight studies, including more than 2,800 patients where open hernia repairs were compared. The analysis disclosed that the Shouldice repair was associated with a 42% reduction in risk of recurrence compared with other techniques. The overall recurrence rate for reports of the Shouldice repair was 4.4%, compared with an overall recurrence rate of 6.2% for the other non-prosthesis open repair techniques. Perioperative complications (hematomas and wound infections) were not significantly different when groups were compared; the single long-term complication, which was chronic pain, also showed no difference when open non-prosthesis hernia repairs were compared.
Open Prosthetic Patch Repair of Inguinal Hernia

The original tension-free open hernia repair technique was developed by Lichtenstein and reported in a series of publications beginning in the early 1990s. Over time, several modifications to the original Lichtenstein tension-free technique have been developed, including the use of plugs to occlude the internal inguinal ring and the Prolene hernia system, which is composed of a patch attached with a column of prosthetic material which is placed in the internal inguinal ring. The column is attached to a prosthetic ring that secures the device in the preperitoneal space. Clinical series using these devices and other similar devices are discussed in this section of the overview.

The Lichtenstein tension-free prosthetic patch repair technique is described by Matthews and Neumayer: the inguinal canal is exposed through a standard groin incision (the authors noted that hernial sacs are reduced, but not specifically ligated); the prosthetic patch used is nonabsorbable and is 8 x 16 cm in size; a slit is created at the junction of the upper two-thirds of the material, with the lower one-third of the prosthesis at the level of the internal ring; two tails created by the slit are positioned to encircle the spermatic cord; the tails then extend beneath the external oblique fascia for 4 cm; the patch overlaps the pubic tubercle by 2 cm; the tails of the patch are tacked with interrupted sutures superiorly to maintain the position of the tails under the external oblique muscle; a continuous suture attaches the prosthesis to the inguinal ligament and the conjoint tendon.

The Lichtenstein repair is also described in detail in an article by Amid and coauthors in the *European Journal of Surgery*, 1996. This article is included as a full-text reprint accompanying some formats of SRGS; readers are encouraged to review the technical details of the procedure described in the article. Amid and coauthors reported outcomes of 3,480 patients available for follow-up that exceeded five years. The hernia recurrence rate was 0.7%. There was only one instance of chronic post-hernia repair pain. More than 90% of patients returned to full activity and work within 14 days of the procedure. Although the “lost to follow-up” rate in this study was 13%, the results are impressive with regard to the two most important outcomes, recurrence and chronic pain.

In the discussion section of the paper, the authors cited data from other reports documenting recurrence rates of 0%–1%. The report from the Swedish Hernia Register, cited earlier, reported a 1% recurrence rate for the Lichtenstein repair.

Matthews and Neumayer noted that the preperitoneal prosthetic patch repair technique includes approaches that enter the preperitoneal space at a point near the inguinal canal, but do not traverse the inguinal canal. The authors reminded us that this technique was pioneered by well recognized authorities in the hernia field, including Nyhus, Stoppa, and Wantz. A description of the preperitoneal prosthetic patch repair technique appeared in an article by Wantz in *The Surgical Clinics of North America*, 1998. This classic article is included as a full-text reprint accompanying some formats of SRGS. The dissection of the preperitoneal space permits the placement of a large prosthetic patch that completely covers the myopectinal orifice; the patch is held in place by intraabdominal pressure. The authors acknowledged that the additional preperitoneal dissection necessary for the open technique results in additional pain and a slow postoperative recovery for many patients. The principles of this approach are now applied to total extraperitoneal laparoscopic hernia repair.

Matthews and Neumayer noted that the use of plugs in femoral hernia management and recurrent hernia defects after open prosthetic patch repair was also pioneered by Lichtenstein. The current approach to the prosthetic plug repair is described in an article by Robbins and Rukow in *Surgical Clinics of North America*, 1993. The authors described an open repair in which the indirect hernial sac is reduced, along with any lipoma of the cord; the internal inguinal ring is then occluded with a cone-shaped plug (a more recent plug that is useful for this operation is the Perfix plug”). After this, a prosthetic patch is used to buttress the inguinal floor in the manner of Lichtenstein (Matthews and Neumayer reported that other hernia devices, such as the Prolene hernia system, provide single devices that occlude the internal ring, cover the dorsal surface of the myopectineal orifice, and provide a buttress patch for the inguinal floor in a single device).
Robbins and Rutkow also reported outcomes of a clinical series involving nearly 1,600 patients; the recurrence rate was noted as 0.1%, although the follow-up interval was not reported. Two-year–follow-up data was provided by Rutkow and Robbins34 in an outcomes report of more than 1,000 patients, with a recurrence rate of 0.2% noted for this series.

The Kugel technique is similar to the Nyhus preperitoneal technique, except that the dissection required in the preperitoneal space is not as extensive. Matthews and Neumayer noted that recurrence rates for the Kugel repair were initially very favorable, but that subsequent literature has not reproduced these early results. An article discussing the results of hernia repair with the Kugel system is by Van Nieuwenhove and coauthors35 in Hernia, 2007. The authors reported outcomes in 450 hernia repairs recorded in a prospective multicenter study, and in a follow-up interval of over one year, recurrences were noted in 1.9% of patients and clinically significant pain was observed in more than 3% of patients. The authors noted that this repair accomplishes the same patch coverage as is obtained with laparoscopic repair without the need for general anesthesia. They also stated that most of their patients did not complain of severe pain, and that nearly all patients ceased analgesic use within one week of operation. The early recurrence rate of nearly 2% in this series means that data from longer term follow-ups will be required before adopting this approach.

Open Hernia Repair
Technique Comparisons

Open prosthetic patch hernia repair was adopted because of a perceived lower long-term hernia recurrence risk. An article by van Veen and coauthors36 in the British Journal of Surgery, 2007, reported long-term (median 10 years) results from a prospective randomized trial comparing tissue-based repairs with prosthetic patch repairs, and compared long-term recurrence rates between the two repair types (the authors noted that a previous report providing two-year follow-up indicated that the prosthetic patch repair was associated with a lower risk of hernia recurrence compared to the tissue-based repair). Seventy-five percent of patients in the tissue-based repair group had Bassini repairs, McVay repairs, or a combination of the two; 25% had Shouldice repair. Prosthetic patch repairs were completed using the Lichtenstein tension-free technique. The cumulative recurrence rate for tissue-based repair at 10 years was 17%, and the recurrence rate after prosthetic patch repair was 1%. Of the tissue-based repairs, the lowest recurrence rates were noted for the Shouldice and the Bassini repairs. The authors concluded that prosthetic patch repair is superior to tissue-based repair for treating groin hernia.

A metaanalysis of randomized controlled trials comparing outcomes for the various types of prosthetic patch hernia repair procedures is by Zhao and coauthors37 in Annals of Surgery, 2009. The authors identified 10 randomized controlled trials that were suitable for inclusion. Publications in languages other than English were searched. Three of the trials compared the Lichtenstein tension-free repair to the prosthetic plug repair and the Prolene hernia system repair. The remaining trials compared the Lichtenstein repair to either the Prolene hernia system repair or the plug repair. Operating time, time to return to full activity, hernia recurrence, and frequency of chronic pain were the main outcomes measures recorded. The only significant difference observed was the shorter operating time with the prosthetic plug and the Prolene hernia system approaches.

Another article comparing outcomes of the various prosthetic patch repairs for groin hernia is by Dalenback and coauthors38 in Hernia, 2009. This article reported outcomes from a prospective randomized trial that enrolled 472 men aged 30–70. The subjects were assigned to receive an operation using the Lichtenstein technique, plug repair, or the Prolene hernia system repair. Operating time was the only significant difference noted, again favoring the plug and the Prolene hernia system repair types. Long-term pain was noted in 3% of patients, while recurrence was noted in 1% of the Lichtenstein repairs and 1.7% of the other repair types. Return to full activity and patient satisfaction did not differ between repair groups; more than 90% of patients returned to full activity within two weeks and essentially all patients who were free of recurrence or pain were completely satisfied with the operation.
Additional studies have sought to analyze the effect of various types of prosthesis (heavyweight vs. lightweight) and various prosthesis attachment methods on the risk of postoperative pain and hernia recurrence. Two articles reporting outcomes of lightweight vs. heavyweight prosthetic material use will be reviewed at this time.

The first article is by Smietanski and coauthors in the British Journal of Surgery, 2008. These authors reported a randomized prospective trial in which 600 patients were randomized and 384 were eligible for evaluation with a one-year follow-up. Patients were assigned to receive polypropylene prosthesis or a partially absorbable composite lightweight prosthesis. The excluded patients were not analyzed after randomization because of protocol violations. Pain at one week and three months was less in the lightweight prosthesis group, but by one year, there were no significant differences in pain between the two groups.

The second article is by Nikkolo and coauthors in Hernia, 2010. In this study, 66 patients were randomized to receive polypropylene prosthesis and 69 were randomized to receive lightweight prostheses. After a short follow-up interval of six months, patients in the lightweight group had lower levels of pain at rest compared with patients who received polypropylene. Quality of life scores and sensations of a foreign body in the groin were not different between the two groups.

Similar short-term differences have been observed in studies comparing prosthesis attachment methods. The first article comparing suture fixation with glue fixation is by Testini and coauthors in the Canadian Journal of Surgery, 2010. These authors reported a single-surgeon randomized trial comparing suture fixation of prosthetic patches in a Lichtenstein tension-free procedure with fixation using fibrin glue or N-butyl-2-cyanoacrylate fixative; sixty-six patients were randomized to each group. On assessment at three months and one year after operation, significantly more patients in the suture fixation group complained of pain or of a foreign body sensation in the groin. The authors concluded that glue fixation is associated with superior results in terms of short-term pain and foreign-body sensation.

The second prosthesis attachment comparison study is by Negro and coauthors in Hernia, 2011. These authors reported a multicenter prospective observational study involving 520 patients. Nearly two-thirds of the patients received fibrin glue as the fixative, while the rest had a suture fixation. At three months after operation, the fibrin glue patients experienced significantly less pain compared to the suture fixation group. By six months postoperatively, there was no difference noted in the degree of pain. Significantly more of the suture fixation patients complained of numbness in the groin area at six months postoperatively. The authors concluded that fibrin glue offers short-term benefits in terms of less pain in the operative area.

Laparoscopic Inguinal Hernia Repair

Matthews and Neumayer listed three potentially useful approaches for groin hernia repair. Common to all approaches are the critical maneuvers including hernia content reduction and a return of these to the intraperitoneal space; visualization of the entire myopectineal orifice; and coverage of the entire myopectineal orifice (including the femoral canal) with a prosthetic patch of sufficient size to overlap the medial, lateral, superior and inferior borders of the orifice by at least 3 cm. Protection of the spermatic cord structures and the nerves of the inguinal canal is important. A critical component of protection is to avoid securing the prosthetic patch with tacks laterally in the area where the nerves are located.

Laparoscopic approaches listed by Matthews and Neumayer include the transperitoneal bilateral patch repair of inguinal hernia—this procedure is done completely within the peritoneal cavity with the placement of a bilayer prosthetic patch. The less reactive layer of the prosthesis is positioned so that it is adjacent to the intestinal surfaces.

The second transabdominal repair method is the transabdominal preperitoneal approach (TAPP), in which a flap of peritoneum is developed and reflected caudally to expose the myopectineal orifice. The prosthetic patch is then placed exactly as it is in the total transperitoneal approach.
The third technique is the total extraperitoneal preperitoneal approach (TEPP), in which entry is made into the preperitoneal space in the lower abdominal midline. A balloon or blunt dissection with the laparoscope is used to develop a space for pneumatic inflation of the preperitoneal area for visualization of the myopectineal orifice. Hernia reduction and prosthetic patch coverage of the entire orifice is then performed.

With the continuing development and wide dissemination of expertise in laparoscopy, refinements of technique have made the laparoscopic approach to inguinal hernia repair more available to patients. As mentioned earlier, the laparoscopic approach is useful in repairing recurrent groin hernias after anterior inguinal repair and in repairing groin hernias in women, due to the importance of complete visualization of the myopectineal orifice. In women to assure that simultaneous femoral hernias are not missed. Unanswered is the question of whether there is significant added benefit to the patient when the laparoscopic approach is used that could justify the procedure’s added cost, need for general anesthesia, and additional operative time. Trends in laparoscopic hernia repair include an emphasis on the avoidance of dissection in the area of the external iliac artery and vein junction with the femoral artery and vein (triangle of doom). There has also been a move away from transperitoneal operations and to the extraperitoneal approach in order to avoid intestinal adhesions and to reduce costs by using instruments that are not disposable and can be reused. The final important trend is the move away from securing the prosthetic patch with tacks or glue and, instead, letting the intraabdominal pressure hold the prosthesis in place.

Matthews and Neumayer reviewed pros and cons for the use of laparoscopic hernia repair. They noted that most studies prior to 2008 suggested that recurrence rates are similar for open and laparoscopic approaches when the laparoscopic surgeon is experienced; the authors also cited data from a Veterans Administration multicenter randomized trial that showed a recurrence rate of more than 10% when outcomes for surgeons who had performed less than 250 laparoscopic procedures were analyzed: the added expense and need for a learning curve has prompted some surgeons to recommend against the use of laparoscopic approaches to groin hernia repair in primary operations; the very low recurrence rates reported for open Lichtenstein repair supported this argument.

Long-term outcomes (mean follow-up of more than three years) from a prospective series of laparoscopic (TEPP) hernia repairs were reported in an article by Thill and coauthors in Acta Chirurgica Belgica, 2008. The authors reported hernia recurrence rates of 1.5% and chronic pain incidence of 2.9% in a group of more than 700 patients from multiple Belgian centers, and concluded that laparoscopic repair is safe and effective with long-term outcomes equivalent to open repairs.

Several articles provided data on the use of lightweight vs. heavyweight prosthetic patches for laparoscopic hernia repair. Results of a randomized prospective trial comparing three types of prostheses were reported in an article by Langenbach and coauthors in Surgical Endoscopy, 2008. The authors randomized 180 male patients with primary inguinal hernia undergoing the TAPP technique to receive one of two types of polypropylene prosthesis or a lightweight composite prosthesis; patients were observed for five years. There was significantly less discomfort and a significantly better quality of life (by standard questionnaire responses) in patients repaired with lightweight composite material up to 12 weeks postoperatively—after this point, the compared differences between groups were not significant. The hernia recurrence rate was 2.2% at five years, and there were no differences in recurrence rates when the groups were compared. The authors concluded that there is no long term advantage to using lightweight composite prosthesis.

A prospective observational study involving 251 patients undergoing primary unilateral or bilateral inguinal hernia repair using the TEPP technique with lightweight prosthetic patches was described in an article by Akolekar and coauthors in Hernia, 2008. In this study, hernia recurrence was the primary endpoint. With a mean follow-up of 14 months, the recurrence rate in the lightweight prosthesis group was 4% compared with 2.8% in the standard prosthetic patch historical control group. Although the differences were not statistically significant, the authors expressed concern that using lightweight prosthesis for hernia repair may lead to a higher recurrence risk.
Chowbey and coauthors46 in Surgical Endoscopy, 2010, provided the results of a prospective randomized trial involving more than 400 patients with bilateral inguinal hernias repaired with the TEPP technique; the patients were assigned to repair with lightweight or standard polypropylene prostheses. With a relatively short follow-up of one year, the patients in the lightweight group had less pain in the short term and experienced an earlier return to full activity. At one year, however, the hernia recurrence rate was higher with the lightweight prosthesis, and this difference almost reached statistical significance. Only one article by Agarwal and coauthors47 in Surgical Endoscopy, 2009 reported equivalent recurrence rates, with significantly better pain control after the insertion of lightweight prosthesis on one side and standard weight prosthetic material on the other side in patients having bilateral hernia repairs—this article, however, only reported only three months of follow-up and cannot, therefore, be used to recommend the use of lightweight material.

The fact that prosthesis fixation with endoscopic tacks has led to a concerning frequency of postoperative pain has stimulated interest in non-tack fixation. An extension of the effort to avoid tack fixation has been the emergence of studies on non-fixation of the prosthetic patch. In patients undergoing laparoscopic hernia repair, the prosthesis is held in position with laparoscopic dissectors during deflation of the laparoscopic preperitoneal space and no other fixation is used.

One article evaluated the results of fibrin glue fixation of prosthetic patches during the laparoscopic repair of inguinal hernias: a randomized prospective trial reported by Lovisetto and coauthors48 in Annals of Surgery, 2007, compared fibrin glue fixation with tack fixation in 197 patients. Pain scores were significantly better and quality of life scores were significantly higher for patients in the fibrin glue fixation group; hernia recurrence was observed in only one patient in this group. The authors concluded that fibrin glue fixation was associated with better results, but that the short follow-up interval handicapped this analysis.

Two articles reported the results of non-fixation of prosthetic patches in laparoscopic hernia repair: a randomized prospective trial of fixation vs. non-fixation of is reported in an article by Taylor and coauthors49 in Surgical Endoscopy, 2008. Five hundred hernias were repaired and each hernia was subject to randomization. Follow-up clinicians were blinded to the method of fixation. The authors found that non-fixation of led to improved pain scores, lower hospital costs, and a low recurrence rate (0 vs. 1 recurrence in the tack fixation group) at 6–13 months follow-up. The authors concluded that non-fixation is associated with significant advantages in terms of pain control and hospital cost without an increased short-term risk of hernia recurrence.

The second article that analyzed data regarding fixation vs. non-fixation is a metaanalysis by Tam and coauthors50 in the World Journal of Surgery, 2010. These authors used standard metaanalysis techniques to identify trials of fixation vs. non-fixation of prosthetic patches during laparoscopic hernia repair involving more than 900 patients. The authors found that short-term results favored non-fixation of the prosthetic patch; non-fixation resulted in less postoperative pain and lower hospital costs without a significant increase in the risk of hernia recurrence.

In addition to repairing recurrent groin hernias after anterior inguinal repair and groin hernias in women, another particular situation where laparoscopic hernia repair might be advantageous is in the patient with bilateral hernia. An article by Wauschkuhn and coauthors51 in Surgical Endoscopy, 2010, presented an analysis of outcomes data from a prospective database of 2,800 patients with bilateral and unilateral hernias. In patients with bilateral hernias, laparoscopic repair was associated with less pain and a more rapid return to normal activities. Recurrence rates at short and long-term follow-up were less than 1% in the laparoscopic group, and this was no different from bilateral open repairs or laparoscopic repair of unilateral hernias. The authors concluded that laparoscopic repair has significant advantages for patients with bilateral inguinal hernia.

Contrasting data about the use of laparoscopic repair for bilateral inguinal hernia were presented in a cost-effectiveness study by Hynes and coauthors52 in the Journal of the American College of Surgeons, 2006. The authors noted that cost-effectiveness analyses rely heavily on patient-reported outcomes, and thus, that long-term frequency of
chronic pain is likely to influence cost-effectiveness analysis more than traditional medical outcomes measures, such as hernia recurrence. As such, this analysis found that laparoscopic hernia repair was not equivalent to open repair at two years in terms of cost-effectiveness. In fact, the chance that laparoscopic repair would be cost-effective was 51%—just slightly more than random chance. For patients with recurrent hernia, the laparoscopic approach was clearly more cost-effective.

The final article discussed in this section of the overview is a Cochrane Collaboration Systematic Review comparing TAPP laparoscopic hernia repair with the TEPP technique. The review is by Wake and coauthors and was published in 2005. The authors identified one small randomized trial and eight non-randomized trials. The data disclosed that the TAPP technique seems to be associated with a greater risk of port site hernia and visceral injury; the TEPP technique is associated with a higher risk of conversion to an open procedure. Outcomes for patients successfully repaired by either technique were no different when the techniques were compared. Overall, the authors concluded that there is not sufficient data to support a choice of one technique over the other. Experience levels of 30–100 cases appear to be necessary for consistently acceptable results in terms of hernia recurrence and postoperative pain.

**Outcomes Comparison for Open & Laparoscopic Inguinal Hernia Repair**

The first article reviewed is a report of a randomized prospective trial comparing the Shouldice tissue-based repair with the TAPP laparoscopic repair. The article is by Arvidsson and coauthors in the *British Journal of Surgery*, 2005. More than 900 patients were randomized and were available for five-year postoperative follow-up. The authors found that hernia recurrence at five years was equivalent for both repair types: 6.7% for the Shouldice repair and 6.6% for the TAPP repair. In addition, surgeon expertise was evaluated by an independent observer who monitored operations performed by individual surgeons. Failure of the surgeon to fulfill the entire operative protocol for each approach was associated with higher inguinal hernia recurrence rates. The authors concluded that the TAPP technique is an acceptable alternative for inguinal hernia repair.

A second study comparing the TAPP technique with the Shouldice operation and the Lichtenstein tension-free prosthetic patch repair is by Butters and coauthors in the *British Journal of Surgery*, 2007. Two-hundred eighty patients were randomized into three groups and assigned to have a Shouldice repair, a Lichtenstein tension-free repair, or a TAPP laparoscopic repair. At a follow-up interval of more than four years, the recurrence rate was 11% for the Shouldice repair and less than 2% for the other two approaches. The authors concluded that the Lichtenstein and TAPP repairs are acceptable alternatives for inguinal hernia repair.

A final trial comparing the Shouldice, Lichtenstein, and laparoscopic approaches is by Pokorny and coauthors in *Hernia*, 2008. In this study, 365 patients were randomly assigned to one of the above surgical repair groups. The rates of complications in the perioperative period were low in all groups; in a follow-up interval of three years, recurrence rates were equivalent for all groups and averaged less than 4%.

Three recent randomized prospective trials comparing laparoscopic to open inguinal hernia repair have been reported. These trials involved a total of nearly 1,700 patients and focused on the TEPP technique. At follow-up intervals of 3–5 years, these trials confirmed that the laparoscopic approach is associated with less perioperative pain and an earlier return to full activity. Although long-term recurrence rates have been statistically similar, there is a consistent slight increase in the hernia recurrence rate for the laparoscopic groups; laparoscopic procedures have also been documented to have higher costs than the open procedures. For many patients and surgeons, the fact that general anesthesia can be avoided in most open repairs is an advantage as well.
Editorial Comment
The fundamental issues to be addressed by the surgeon and the patient when contemplating elective inguinal hernia repair include the expertise and experience of the surgeon, the willingness of the patient to balance the short-term and long-term risks of pain with the cost of various operative approaches, and the necessity for full understanding of the potential outcomes for the available procedures. Recurrence rates are probably lowest for the Lichtenstein repair technique, although the rapidly progressing field of laparoscopic hernia repair is narrowing this gap. In the hands of an experienced laparoscopic surgery team, outcomes of laparoscopic repair and Lichtenstein repair are probably equivalent. The laparoscopic approach also has clear advantages in women who require hernia repair and in patients requiring repair of recurrent hernias. The risk of long-term pain in the groin is approximately 2%–5% for open repair and may be somewhat less for laparoscopic repair, although evidence is not strong enough to make an unequivocal statement regarding this risk after laparoscopic repair.

Isolated Femoral Hernia Management
Options for managing isolated femoral hernia include the tissue-based McVay repair, open or laparoscopic preperitoneal prosthetic patch repair, and femoral plug repair. An article presenting the extensive experience of the Shoul dice Hernia Clinic with isolated femoral hernias is by Chan and Chan in the Journal of the American College of Surgeons, 2008. The article presented data describing outcomes in 225 patients available for five-year follow-up. If the patient had not had a prior inguinal hernia repair, a “complete groin repair” was performed: this operation is similar to the classic McVay repair. Patients who had had a prior groin exploration and were suspected of having a recurrent hernia in addition to a femoral hernia were advised to have an open or laparoscopic preperitoneal prosthetic patch repair. The prosthetic patch repair was a standard operation designed to completely cover the myopectineal orifice.

Patients who had had successful groin repair and who had an isolated femoral hernia had a femoral hernia prosthetic plug placed via a femoral exploration incision with dissection and reduction of the femoral hernial sac. The authors reported a five-year recurrence rate of 3% for these procedures, with no particular procedure having a different recurrence risk. The authors concluded that the operative strategy for an isolated femoral hernia can be chosen based on patient characteristics.

Results from a randomized prospective trial comparing the preperitoneal prosthetic patch repair with the femoral plug repair were presented in an article by Chen and coauthors in Surgery, 2010. The authors reported a trial in which 85 patients were assigned to receive a preperitoneal prosthetic patch repair or a femoral plug occlusion of the femoral canal after reduction of the femoral hernial sac. The follow-up interval averaged more than three years. It was discovered that seroma formation and the sensation of a foreign body in the groin were both more frequent in plug patients. In addition, the three-year recurrence rate for plug patients was 10%; no recurrences were observed in the preperitoneal prosthetic patch repair group. The authors concluded that the preperitoneal prosthetic patch repair is a superior operation for patients with isolated femoral hernia.

Complications of Inguinal Hernia Repair
Short-term complications of inguinal hernia repair include hematomas, seromas, SSIs, and groin pain. Long-term complications include recurrence, chronic pain, and testicular dysfunction with or without painful orchitis. With prosthetic patch repair, the most feared complication is deep infection, which is, thankfully, rare.

Matthews and coauthors in the American Journal of Surgery, 2007, used data from the Veterans Administration multicenter randomized trial of open vs. laparoscopic hernia repair to evaluate data relative to complication rates and risk factors for complications. More than 2,000 patients were entered into the study. The data disclosed that hernias extending into the scrotum and recurrent hernias were strong predictors of both short-term perioperative and long-term complications. High scores on the mental functioning segment of the SF-36 health question-
naire predicted long-term complications. Hematomas and nerve injuries were the most common short-term complications of open repair; peritoneal tears were the most common perioperative complication of laparoscopic repair. Bleeding complications were unusual in both repair types. Chronic pain at any level was encountered in 8% of patients, and pain requiring treatment was encountered in 3% of patients. Younger age and a preoperative history of significant inguinal pain were predictors of long-term pain requiring treatment.

Recurrent Inguinal Hernia Management

An article by Itani and coauthors in the *Journal of the American College of Surgeons*, 2009, dealt with the problem of recurrent inguinal hernia. The authors noted that there is a wide variance (1%–17%) for reported recurrence rates for inguinal hernia. Many studies reported only two years of follow-up, even though many recurrences appear after this time interval. The authors also disclosed that 10% of “recurrences” reported are femoral hernias, suggesting that they were missed during the first operation. Data from watchful waiting studies for minimally symptomatic hernia could apply to recurrent hernia as well, according to the authors. There seemed to be no increased risk of acute hernia complications associated with watchful waiting for recurrent hernia (watchful waiting is less appropriate for older patients, who may develop serious comorbid risk factors with delayed operations).

The operation crossover rate due to increased pain was higher for recurrent hernia—35% at two years. The choice of operation for recurrent hernia depends on the condition of the tissues of the groin, the patient’s gender, and the expertise of the surgeon. The authors stressed that it is important for the surgeon to review the prior operative note so that full familiarity with the prior operation is obtained. For patients who have had a prior anterior operation, the operative choices include open or laparoscopic preperitoneal repair or exploration of the prior anterior operation with plug occlusion of hernia defects. Plug occlusion was used very successfully by Lichtenstein and colleagues for many years, while the preperitoneal approach has the advantage of operating through an undisturbed tissue plane. Recurrence of a hernia after laparoscopic or open preperitoneal repair can be repaired satisfactorily with the Lichtenstein approach.

Two randomized prospective trials comparing the TEPP laparoscopic technique for treatment of recurrent inguinal hernia compared with redo anterior Lichtenstein repair have been completed. These trials enrolled nearly 250 patients and follow-up was for more than three years in both trials. The data disclosed that re-recurrence rates were not statistically different for the two approaches, although trends suggest a lower recurrence rate for the laparoscopic group over time; pain and recovery times were also better with the laparoscopic approach. The authors concluded that the laparoscopic approach is the preferable approach for patients who have had a prior anterior repair with subsequent hernia recurrence.

Bisgaard and coauthors reported results of a nationwide eight-year follow-up study from a national database of operations for recurrent inguinal hernia. The results confirm data reported from the randomized prospective trials: re-recurrence is seen less frequently when laparoscopic repair is used for a recurrence that followed a prior anterior operation.

Chronic Pain after Inguinal Hernia Repair

As noted previously, chronic groin pain requiring treatment is encountered in approximately 3% of patients observed long term after inguinal hernia repair. High levels of preoperative pain and younger age group are associated with increased risk of postoperative pain; patients need to be informed of this risk. In this section of the overview, we will review data on preventing nerve injury as a means of reducing chronic groin pain risk.

Groin pain after hernia repair can be the result of causalgia-like pain due to injury to one of the inguinal nerves or entrapment of the nerve by a suture or a tack. Pain can also be caused by chronic ischemic orchitis. There is often a visceral component to the pain as well.
Chronic pain is multifactorial and difficult to evaluate: many experienced surgeons recommend that a multidisciplinary approach be taken with these patients that includes a pain specialist consultation and multilevel pain therapy. The decision to offer operative treatment for the pain is difficult, and the multidisciplinary approach will be able to identify patients who may benefit from surgical management.

**Preventing Chronic Pain after Inguinal Hernia Repair**

Two approaches have been recommended for preventing postoperative chronic inguinal pain: these include identifying and protecting the three main inguinal nerves during the anterior Lichtenstein operation, and planned neurectomy of one or more of the inguinal canal nerves. Data on the effects of each of these approaches need to be interpreted cautiously; many available articles supply short-term follow-up only, and it is well known that pain tends to improve over time after hernia repair. Available articles also report data from all patients—not just patients at high risk for pain (young age, high level of preoperative pain) and this may confuse the interpretation of outcomes; some of the available data are discussed in this section of the overview.

A European multicenter trial was conducted and its results were reported in an article by Alfieri and coauthors in *Annals of Surgery*, 2006. The study compared the identification and protection of the three inguinal canal nerves with the routine division of the nerves. More than 900 patients were enrolled and all patients were observed for at least one year. The data disclosed that identification and protection of the nerves was associated with a long-term chronic pain risk of 0.5%. Division of the nerves was associated with a significantly increased risk of chronic pain.

The technique of identifying the three inguinal nerves is the topic of an article by Lange and coauthors in the *British Journal of Surgery*, 2009. The anatomic features of the inguinal area which facilitate nerve identification are illustrated in the article and this drawing is reproduced as Figure 6 with permission. Readers are encouraged to review this article and the illustration. One prospective trial and one metaanalysis evaluating the potential effects of routine neurectomy have been published. Unfortunately, these trials include short-term follow-up only and they also include patients at low risk for chronic post-hernia repair pain. Given the status of the data currently, there seems to be significant benefit for identification and protection of the three inguinal nerves during anterior Lichtenstein hernia repair and insufficient data to support routine neurectomy.

Omission of hernia sac ligation has been suggested as a means of reducing chronic inguinal pain. This topic is the focus of a report of a randomized prospective trial comparing ligation with no ligation of the hernial sac. The article is by Delikoukos and coauthors in *Hernia*, 2007. The data from the trial disclosed that pain was less in the non-ligation group early after operation, but that the differences between the two groups had disappeared by three months.

**Treating Chronic Pain after Inguinal Hernia Repair**

Options for the operative treatment of chronic post hernia repair pain include removal of the implanted prosthetic patch and three-nerve neurectomy. These options are discussed in an article by Aasvang in *Annals of Surgery*, 2009. Data on 23 patients observed for at least 6 months are reported. There was significant improvement in pain scores and quality of life after the procedure. The author noted that pain scores and quality of life scores worsened in three patients. The author recommended careful preoperative pain evaluation and referral of patients to specialized hernia centers that are experienced in dealing with this complication.

A potentially beneficial approach to treatment of chronic neuropathic pain after hernia repair was reported in an article by Kline and coauthors in the *American Journal of Surgery*, 2013. The authors described a technique where a nerve block using a local anesthetic is performed for patients suspected of having neuropathic pain (electric shock sensation, stabbing pain). If the block effectively relieves the pain, the procedure is repeated in the operating room combining the local anesthetic with one ml of methylene blue dye. If this block is successful, a small incision is made and the dye-stained tissue is removed. The authors reported that nerve tissue was
recovered in all excised tissue. Seventeen patients suffering from post-hernia repair pain were treated and at one year of follow-up, pain was relieved in all of these patients.

**Male Infertility after Inguinal Hernia Repair**

It is well recognized that too-tight closure of the internal inguinal ring can give rise to ischemic orchitis; leaving sufficient room at the internal ring to admit the tip of a hemostat is effective in preventing this complication. It is difficult to determine whether testicular function is impaired, leading to infertility after hernia repair, since infertility is a multifactorial medical problem. Given the many options for assisted fertilization currently available, many patients do not seek evaluation; thus, the estimates of infertility after hernia repair in men probably underestimate the magnitude of the problem.

Available literature has proposed that the presence of the hernia impairs testicular perfusion and this perfusion is normalized after repair.72 Other authors have documented temporary reductions in testicular perfusion and sperm motility after hernia repair.74,75 Evaluation of long-term effects on testicular perfusion and sperm motility after inguinal hernia repair has produced conflicting results.76-78 The safest advice appears to be that surgeons should advise patients who want to have children after their hernia operation about a minimal chance of testicular dysfunction that the current literature does not accurately quantify; patients may wish to cryopreserve sperm as a precaution.

**Ventral & Incisional Hernias**

Ventral protrusion of the abdominal wall can occur as a result of congenital weakness of the anterior abdominal wall, resulting in midline eventration (diastasis recti) that is not a true hernia; however, patients may wish to have the
weakness repaired because of the unpleasing appearance of the anterior abdomen. Epigastric hernias are defects in the midline abdominal wall fascia that contain preperitoneal fat, while umbilical hernias arise in a congenital defect at or adjacent to the umbilicus and in the midline between the xiphoid and umbilicus. Umbilical hernias may be associated with surgical incisional hernias as well. Hernias of the lateral rectus area (Spigelian hernia), lumbar hernias, and hernias of the semilunar line of the posterior rectus sheath are other anterior abdominal wall hernias that are uncommon in surgical practice. Lumbar hernias may occur as congenital weakness of the posterior-lateral body wall or as a complication of traumatic injury. Management of these unusual hernias will not be part of the following review.

Incisional hernias are an increasingly common problem encountered in general surgery. These hernias may emerge as a complication of lower abdominal incisions used for gynecologic operations or after incisions for other types of abdominal operations. Incisional hernias may develop in up to 15% of anterior abdominal incisions. After the repair of an incisional hernia, a recurrence of the hernia, usually appearing in the first 3–6 months after the repair, is reported in up to 50% of these repairs depending on risk factors (elderly patient, diabetes mellitus, immunosuppression, smoking, and COPD) and the presence of a high-risk wound (open abdomen, skin grafted abdomen, intestinal fistula) at the time of repair.

Repairing incisional hernias may be accomplished with native tissue closure or with prosthetic patch closure. Securing prosthetic patch repairs may be challenging in lower abdominal incisional hernias that develop after gynecologic operations because of the need to secure the prosthesis to bone and avoid injury to the bladder and other visceral structures. Prosthetic repair in a high-risk wound is also a challenging problem. These topics will be reviewed and literature supporting effective methods of management will be presented in this section of the overview.

Classification of Ventral & Incisional Hernias

An article presenting a classification system for ventral and incisional hernias is by Muysoms and coauthors in Hernia, 2009. This article is supplied as a full-text reprint accompanying some formats of SRGS. The authors reported suggested classifications of primary ventral (epigastric and umbilical) hernias and lateral hernias (Spigelian and lumbar) that were based on expert opinion offered by members of the EHS. Primary hernias were classified according to location (lateral or midline) and the size of the hernia defect. Incisional hernias were also classified by location and defect size. The authors of the classification system recommended that the length and width of each hernia defect be recorded. Another recommendation was that the number of prior attempts at hernia repair also be recorded.

Practice Guidelines for Ventral & Incisional Hernias

Practice guidelines for managing ventral and incisional hernias have been promulgated by the SSAT; a revised version was published in 2014. These guidelines are available free of charge on the society’s website: www.ssat.com. These guidelines note that the main indications for repair are gradual increase in size of the hernia, hernia pain, and the development of an irreducible hernia, especially if there are signs of intestinal obstruction or ischemia. Patient complaints of pain at the site of the hernia and increase in size of a hernia bulge are the most frequently recorded elements of the patient history. On physical examination, the hernia defect may be palpable and there is often direct tenderness at the fascial borders of the defect. Physical examination may underestimate the extent and severity of the hernia; frequently, multiple fascial defects are present. The guidelines suggest that CT imaging may be useful for characterizing the number and location of hernia defects.

The guidelines also note that the repair of incisional hernias may be undertaken using open or laparoscopic techniques. Open repairs may use native tissue closures for small defects (< 3cm). Larger defects require mobilization of native tissue (components separation, discussed later in
the overview), development of tissue flaps either locally or from a remote location, and, occasionally, tissue expansion techniques may be used. Prosthetic patch repairs can be accomplished with open or laparoscopic techniques. Open repairs use either standard polypropylene or composite prostheses. Lightweight prostheses may be useful for selected patients. Composite material is useful if the inner surface of the prosthesis will, because of circumstances of abdominal wound anatomy, be adjacent to the intestine. The less adhesive surface can be positioned to contact the bowel. Prosthetic patches can be placed in the defect and sutured to the defect edges in the retrorectus preperitoneal position (with closure of the peritoneum or hernial sac to protect the bowel), inside the peritoneal cavity, or on the surface of a fascial closure as a reinforcing prosthesis.

According to the SSAT’s practice guidelines, laparoscopic incisional hernia repairs have a potential advantage in that all fascial defects can be visualized from within the peritoneal cavity. Downside risks of laparoscopic prosthetic patch repair are the necessity to place the prosthesis in contact with the bowel and the risk of bowel injury or injury to other visceral structures during dissection. Prostheses may be secured with preplaced sutures at 4–6 points along the edge of the prosthesis with passage of the sutures through the abdominal wall via small skin incisions and tying the anchoring sutures in the deep subcutaneous space. The practice guidelines noted that serious complications of incisional hernia repair include visceral injury with fistula formation, prosthetic infection, adhesive intestinal obstruction, SSIs, and hernia recurrence; recurrence risks are also reviewed in the practice guidelines: recurrence rates of up to 50% have been reported with native tissue primary suture repairs; prosthetic patch repairs have reduced the recurrence risk from 5% to a maximum of 35%. Published reports of laparoscopic repairs record recurrence risk of 10% or less, albeit with short follow-up intervals.

**Abdominal Closure Techniques for Preventing Incisional Hernias**

Adopting a closure technique for vertical midline incisions that minimizes incisional hernia risk would be highly desirable. An article that reviews a technique of midline abdominal closure that has proven effective in preventing incisional hernias is by Israelsson and Milbourn in *The Surgical Clinics of North America, 2013*. This article is supplied as a full-text reprint accompanying some formats of SRGS. The authors stressed the importance of using a continuous suture of size 2-0. The suture should be monofilament and nonabsorbable or slowly absorbable. A continuous suture is used; the suture begins with a self-locking knot that is illustrated in Figure 7. The authors recommended placing the closure sutures 5–8 mm from the wound edge and placing these in the aponeurosis only without incorporating muscle tissue in the closure. The wound edges should be approximated but not compressed. The suture is measured and the length of the incision is measured and the suture length to wound length (SL:WL) ratio should not be less than four.

The authors noted that available evidence does not provide clear support for superiority of one type of incision over another for protection against wound dehiscence. A contrasting view was put forward in an article that described results from randomized prospective trial comparing cholecystectomy in female patients performed via a transverse incision or a vertical incision; this article is by Halm and coauthors in *Hernia, 2009*. The authors randomized 150 women in this trial. Over a short follow-up interval of 12 months they noted incisional hernias in 14% of the vertical incisions and 2% of the transverse incisions. They also found that the transverse incisions were associated with less pain and analgesic use and a higher rate of patient satisfaction. Technical difficulty of the operation was not increased in either group. The authors concluded that outcomes of transverse incisions for upper abdominal operations are superior to those observed in patients who have had upper abdominal vertical incisions.

Israelsson and Milbourn noted that surgical wound infection depends on the degree of contamination and on the amount of necrotic tissue in the wound. They emphasized the importance of minimizing the amount of necrotic tissue and reviewed evidence supporting the fact that the technique they described is associated with less necrotic tissue than other closure methods. Israelsson and Milbourn provided evidence that large stitches that incorporate fascia, muscle, and subcutaneous fat are prone
to cut through tissue and loosen, while small stitches (that they recommended) are not prone to this problem. They also cited evidence that the risk of incisional hernia is reduced by more than 60% with use of the recommended technique.

Another article that provided perspective on the topic of prevention of dehiscence and incisional hernias is a metanalysis of available prospective trials comparing continuous vs. interrupted suture techniques for closure of vertical abdominal incisions. The article is by Gupta and coauthors in the *Asian Journal of Surgery*, 2008. The authors identified 23 studies that were suitable for inclusion. Interpretation of some of the studies was difficult because the suture technique was not described in detail. Analysis of outcomes disclosed that interrupted suture technique was associated with a lower risk of wound dehiscence, but the risk of incisional hernias (12%–18% in the included studies) did not differ between the observed groups. Of the suture techniques reported, the interrupted far-near, near-far Smead-Jones technique was associated with the lowest risk of dehiscence and incisional hernias. The authors cited data from biomechanical studies that suggest the Smead-Jones technique provides a secure closure without impairing blood flow to the fascial tissues.

The next article discussed is by Bloe- men and coauthors in the *British Journal of Surgery*, 2011. These authors reported a randomized prospective trial comparing nonabsorbable monofilament continuous suture closure to continuous suture closure using a slowly absorbable suture. Closure was by a continuous single strand suture technique with a suture-to-incision length ratio of 4:1. The authors enrolled 523 patients and assigned these evenly to the two arms of the study. Follow-up was four years in all patients. The authors found an incisional hernia rate of 23.7% of the nonabsorbable suture and 29% for the absorbable suture arm. The difference was not statistically significant. The authors speculated that the higher rate of incisional hernias reported in this article compared with other studies may be explained by the fact that all patients underwent physical examination and abdominal wall ultrasonography during follow-up. They noted, however, that the lack of difference in outcomes suggests that slowly absorbable suture might be a safe alternative for abdominal wound closure.

El-Khadrawy and coauthors in *Hernia*, 2007, randomized 40 patients into two equal groups. High risk patients were identified for randomization by discovery of one or more of the following factors: obesity, liver disease, renal disease, malnutrition, malignancy, lung disease, and diabetes. One group underwent conventional closure of a vertical midline wound and the second group had incision subfascial preperitoneal reinforcement of the closure with
polypropylene prosthetic material positioned and fixed to
the overlying rectus muscle with 4–6 interrupted perim-
eter sutures. The frequency of local and systemic compli-
cations was equivalent in the two groups. There were no
instances of prosthesis infection. The incisional hernia rate
in the prosthesis-reinforced group was 5% compared to
15% in the conventional closure group after two years of
follow-up. This study is handicapped by small numbers
and short follow-up periods, but the results suggest that
prosthetic reinforcement is safe and potentially useful for
protection against incisional hernia development.

Native Tissue & Prosthetic Patch Repairs
of Incisional Hernias

In the SSAT practice guidelines, suture repair of small
abdominal wall defects (2–3 cm in diameter) was the
recommended technique. Closure of larger defects re-
quires mobilization of the layers of the abdominal wall.
Bilateral mobilization of the layers of the abdominal wall
using the components separation technique will permit
the closure of defects at or cranial to the semilunar line in
the posterior rectus sheath that are 8–20 cm in diameter.
Components separation can provide definitive native tis-
sue closure and/or provide protection for the intestines
so that the prosthetic patch material that is placed to
reinforce the native tissue closure does not contact the
intestine. Several techniques of components separation
and other native tissue techniques will be reviewed at
this time.

A systematic review of repair techniques for large
incisional hernias was presented by Eriksson and coau-
thors85 in Hernia, 2014. The authors identified 14 studies
for inclusion in the analysis. They emphasized that there
was marked heterogeneity in the selected studies that
limited generalizability of the conclusions of the stud-
ies. Based on their analysis, they concluded that compo-
nents separation without prosthetic patch reinforcement
could not be recommended for managing large incisional
hernias; instead, components separation with prosthetic
patch reinforcement placement intraperitoneally or in the
sublay position behind the rectus muscles with at least
a 2 cm prosthetic material extension on all sides of the
defect were the most effective approaches. Using these
approaches in clean, uninfected hernias resulted in recur-
rence rates that were consistently below 10%. Prosthesis
infection was unusual in uncontaminated wounds and
occurred in less than 5% of patients. The authors con-
cluded that strong evidence to support a choice of one
prosthetic patch position over another was not available.
The data reviewed suggested that using a prosthetic patch
in an inlay position— where the prosthesis is sutured to
the edges of the hernia defect—was associated with an
increased risk of recurrence.

An article that reviewed techniques for native tissue
closure of incisional hernia defects is by de Vries Reilingh
This article presents a systematic review of the literature
on native tissue closure techniques for large incisional
hernia defects, and reports several series documenting a
recurrent hernia rate after autologous tissue closure us-
ing one of the mobilization techniques to be in the range
of 18%. Generally, recurrent hernias after native tissue
mobilization and closure are small and minimally symp-
tomatic. The authors described the da Silva technique for
managing medium sized defects in the abdominal midline
above the waist. The authors noted that recurrent hernia
rates after use of this technique have been reported to be
low, but that the overall quality of the reported studies
is poor. Overall, the components separation technique
is the most dependable native tissue closure approach.

De Vries Reilingh and coauthors noted that defects
above the waist of up to 20 cm in diameter can be closed
with the da Silva technique. A clear description of the
components separation technique along with a summary
of reports of outcomes of this technique was presented
in an article by de Vries Reilingh and coauthors87 in the
Journal of the American College of Surgeons, 2003. The au-
thors noted that available reports cite risk of reherniation
ranging from 3% to 30% depending on the risk status
of the patient and the presence of infection or intestinal
fistula in the wound to be closed. Overall, the authors
concluded that components separation is the most useful
native tissue closure technique.

Components separation has limited application to
defects in the lower abdomen or defects that are off the
midline. In these areas, a lack of a mobilizable posterior
rectus sheath reduces the amount of coverage that can
be made available. Partial coverage of lower midline de-
flicts can be achieved by placing vertical incisions in the anterior rectus fascia and rotating this layer into the midline. Remote tissue flaps may be needed for such defects. In their 2007 article, de Vries Reilingh and coauthors described the use of the tensor fascia lata flap. This technique generally requires consultation with reconstructive surgery specialists, and the donor site defect created for the use of a unilateral or bilateral tensor fascia lata flap is a disadvantage, but the flap does supply well vascularized and strong tissue for defect repair.

A comparison of outcomes of native tissue vs. prosthesis repair of incisional hernias is by de Vries Reilingh and coauthors in the World Journal of Surgery, 2007. This randomized prospective trial enrolled 39 patients. Hernia repair was accomplished with the components separation technique or with a prosthetic patch repair using low-reactivity prosthesis (expanded polytetrafluoroethylene) placed inside the peritoneal cavity and sutured to the abdominal wall. The authors noted that the rate of wound complications was significant (55%–65%) in both groups. Notably, none of the components separation repairs broke down as the result of a wound complication, but more than 50% of the prosthesis implants had to be removed because of wound complications. Recurrent hernia was diagnosed in 50% of the components separation patients and a similar percentage of prosthetic repair patients whose prosthetic material was retained over the three-year—follow-up interval. The authors concluded that components separation repair is preferable if this approach is feasible for the patient’s hernia type.

Currently, the majority of large incisional hernias are repaired using mobilized native tissue and prosthetic patch reinforcement. By employing the components separation technique, a midline native tissue closure can be accomplished and can be reinforced with a prosthetic patch. The conventional components separation technique was described by Ramirez in 1990: this technique required the creation a large anterior skin and subcutaneous tissue flap on each side of the midline of the abdomen; the external oblique aponeurosis was incised parallel to the rectus muscle to allow movement of the rectus sheath toward the midline; the posterior rectus sheath was dissected away from the rectus muscles allowing additional mobility; modifications of this technique included the use of anterior rectus fascia rotation flaps to supply additional tissue for midline closure.

An article that provided perspective on the topic of components separation for repairing incisional hernias is by O’Halloran and coauthors in Surgery, 2014. The authors reported outcomes data on 85 consecutive incisional hernia repairs that used components separation with or without prosthetic patch reinforcement. Over 90% of the patients had had a previous hernia repair and all patients were considered “high-risk” for hernia recurrence based on risk factors such as diabetes, obesity, smoking, etc. The authors observed an overall hernia recurrence rate of 14.1% over a follow-up interval averaging 14 months. When prosthesis reinforcement was used, the hernia recurrence rate was 11%. The authors suggested that prosthetic patch reinforcement using conventional or biologic materials (depending on the risk for infection) be included in all repairs of incisional hernias that are more than 3 cm in diameter and for all hernias in which components separation technique is used.

A modification of the components separation technique that permits additional tissue mobility and creates a large space for prosthetic patch placement was described in an article by Carbonell and coauthors in Hernia, 2008. These authors presented a technique that avoids the creation of the large subcutaneous flaps needed for Ramirez’ technique, and creates, in addition, a large retro-muscular space that can be used for placement of large, reinforcing prosthetic patches: the posterior rectus sheath is dissected from the rectus muscles; when the lateral wall of the rectus sheath is reached, it is incised, and the space between the internal oblique muscle and the transversus abdominis muscle is opened, and the dissection is carried laterally, superiorly, and inferiorly to develop a space for placement of a prosthetic patch; this dissection also creates tissue mobility that permits additional movement of the posterior rectus sheath toward the midline. The authors reported outcomes data on 20 patients. At an average follow-up interval of 10 months, one hernia recurrence occurred and this was the result of insufficient extension of the prosthetic patch at the upper end of the hernia. Three patients had wound complications, but prosthesis
removal was not required. There were no instances of abdominal wall instability or lateral hernia secondary to the dissection.

A laparoscopic method for components separation repair of incisional hernias is presented in an article by Azoury and coauthors in Surgical Endoscopy, 2014. This article is supplied as a full-text reprint accompanying some formats of SRGS. The authors described a technique that uses endoscopic balloon dissection of the space between the external oblique and the internal oblique layers of the abdominal wall. Mobilization of the tissues toward the midline permits closure of the hernia defect with sutures passed through the abdominal wall with a suture passer. The technique is nicely illustrated in the article. The repair is reinforced with an underlay prosthesis placed in an intraperitoneal position. The authors compared outcomes in 76 patients treated at their center. Twenty-three of the patients had the endoscopic components separation technique used, and the remainder had open components separation with prosthetic patch reinforcement repair of the hernia. The authors observed wound complications (mostly minor) in nearly 30% of patients. Follow-up was relatively short, averaging 8 months. There was one hernia recurrence in the endoscopic group and no recurrences observed in the open repair group.

An article that compared outcomes of prosthetic patch repair of incisional hernias with suture repair using native tissue was presented by Burger and coauthors in Annals of Surgery, 2004. The authors noted that despite a great deal of clinical evidence supporting the superiority of prosthetic patch repairs for incisional hernias, surgeons continue to perform native tissue suture repairs. The authors cited data from one European country that 85% of incisional hernia repairs performed in that country were native tissue suture repairs. They further noted that their group published a randomized controlled trial comparing native tissue suture and prosthetic patch repairs that confirmed better results with prosthetic patch repairs. The current article is designed to provide long-term—follow-up data from the patients who participated in that trial: the original trial enrolled 200 patients. Data from 126 patients were available for follow-up that averaged nearly 80 months for both groups. The authors found that the estimated 10-year recurrence rate for native tissue suture repair was 67%; for prosthetic patch repair, the 10-year cumulative recurrence rate was 17%. The authors concluded that prosthetic patch repair was superior to native tissue suture repair in terms of recurrence. Cosmetic outcomes, pain frequency and severity, and quality of life were similar at long-term follow-up in the two groups.

Although available data support prosthetic patch reinforcement of hernia repair as the most effective type of open repair technique, there is a wide variance in prosthetic patch utilization among surgeons, as noted previously. This topic is addressed in an article by Gray and coauthors in the American Journal of Surgery, 2008. These authors noted that incisional hernia repair is a common operation, with more than 100,000 repairs done annually in the United States. They cited data that associated prosthetic patch repair with a 50% reduction in recurrent hernia risk. To document patterns of prosthetic material usage, the authors used data from more than 10,000 incisional hernia repairs done in several Veterans Administration hospitals. The authors found that high-performing hospitals (based on NSQIP criteria) used prosthetic patch techniques for hernia repair four times as often as low-performing hospitals. The authors also noted that while prosthetic repair is associated with better outcomes overall, hernia recurrence is still observed in almost 25% of patients; thus, the authors recommended continued research to find improved methods of hernia repair.

Additional data confirming improved outcomes associated with prosthetic patch repair are found in a Cochrane Collaboration Systematic Review by den Hartog and coauthors. This systematic review concluded that available evidence supported using prosthetics for incisional hernia repair. The available evidence was too insufficient to recommend a method of prosthesis placement. The review data disclosed that prosthesis use frequency has steadily increased among surgeons who repair incisional hernias (65% according to data in the review). In the article by Gray, noted above, the frequency of prosthesis use for incisional hernia repair is 70%. The systematic review concluded with a recommendation that prosthesis reinforced repair be the preferred approach in repairing incisional hernias.
A clear and valuable review of the available types of prosthetic materials and the advantages and disadvantages of each type is provided in an article by Shankaran and coauthors\textsuperscript{96} in Annals of Surgery, 2011. Readers are encouraged to review this article in detail to gain familiarity with the various types of materials available for incisional hernia repair. Useful algorithms are also included in the article—these algorithms match hernia repair approaches with hernia types and patient risk factors.

An article that analyzes data on the relationship between prosthetic patch type and placement to subsequent complications after incisional hernia repair is by Snyder and coauthors\textsuperscript{97} in Surgery, 2011. The authors analyzed outcomes data with 80 months of follow-up in a group of more than 1,400 patients in Veterans Administration Medical Centers who underwent incisional hernia repair. The authors found that over the 80 month interval, nearly 25% of patients underwent a second operation, and most of these were done for repeat incisional hernia repair (incidentally, these patients would have been candidates for laparoscopic repair if their previous repair had been done with an open approach, and would have been candidates for an open approach if the prior repair had been done laparoscopically). There were no data supporting increased risk for reoperation with the use of any particular prosthetic type or placement. The authors found that prosthetic patches placed in the retrorectus preperitoneal position were more likely to be associated with increased re-repair operation difficulty. The data confirmed the safety of bi-layer patches placed in the intraperitoneal position during laparoscopic incisional hernia repair. There was an increased risk of reoperation after placement of biologic prostheses and this reflected the frequent emergency and high-risk operations done when this type of prosthetic material was used. The authors noted that it is very important for the surgeon performing a primary operation of incisional hernia to carefully record all the events of the operation, including the prosthetic type, size, and location of the prosthesis. Similarly, it is important for surgeons approaching a re-repair operation to review the data from all prior operations.

Data that can provide guidance in using lightweight or heavy weight prosthetic patches for incisional hernia repair was presented in two articles. The first was an experimental study that focused on tissue incorporation of lightweight prosthetic materials compared to heavyweight materials; this article is by Pascual and coauthors\textsuperscript{98} in Surgery, 2012. The authors created defects in the abdominal walls of rabbits and repaired these with heavyweight (polypropylene) or lightweight (two types of PTFE) prostheses. The prosthetic material was removed at 90 and 180 days after implantation and studies of collagen deposition and immune response to the implants were performed. The data analysis showed that the immune response to the implants was related to pore size: large pore material had a more pronounced immune response that was consistent with higher levels of immune cell passage through the large pores. This response led to a high rate of seroma formation. The authors cautioned that responses such as seroma formation are likely to be species specific and these data cannot necessarily be used to predict human immune response and risk of seroma formation. At each point in time, the strength of the materials and levels of collagen deposition were equivalent.

The second article is a clinical study by Petro and coauthors\textsuperscript{99} in Hernia, 2015. The authors reported outcomes on 36 patients who had incisional hernias repaired with lightweight prosthetic material. All patients had closure of the peritoneum and anterior fascia and the prosthetic patch was placed in the retrorectus position. At a follow-up interval averaging 14 months there were eight hernia recurrences. Seven of the recurrences were associated with structural failure of the prosthetic material. The authors noted that there have been reports of structural failure of several types of lightweight prosthetic material used to repair incisional hernias. Data cited by the authors noted that the reported structural failures had been observed mainly in patients who had not had anterior fascial closure, and thus the failures might not have been due to weakness of the prosthetic material. They also emphasized that the number of structural failures being reported in patients who had closure of both peritoneum and anterior fascia in addition to prosthetic reinforcement with lightweight material are increasing for several types of prosthetic material. The authors concluded that lightweight prostheses should be used with caution.
for repairing incisional hernias, especially in patients with increased recurrence risk factors (obesity, positive smoking history, diabetes, etc.).

Biologic absorbable prosthetic material can also be used to repair incisional hernias. These materials are used primarily for patients with contaminated or infected wounds. One type of biologic prosthesis, acellular dermis, has potential value for incisional hernia repair, and two articles provide perspective on the use of this material: Kissane and Itani 100 presented a systematic literature review in *Plastic and Reconstructive Surgery*, 2012. The authors stated that they were not able to identify any studies with moderate or strong evidence; there was only one study where outcomes were followed prospectively and all studies were single-center studies. The selected reports evaluated human and porcine acellular matrix materials. The overall recurrence rate was 20% and the wound complication rate approached 25% at a mean follow-up interval of 25 months. The authors noted that human acellular dermal was associated with a recurrence rate of 30%, and they emphasized that this material tends to stretch—for this reason, some of the recurrences might actually be evolutions. Also, early in the reported experiences, these prostheses came in small sheets that had to be sewn together to cover a sizable hernia defect: this factor could have led to higher recurrence rates. Given the expense of these materials and the consistently high failure rates, the authors recommended that high-quality prospective studies be performed to evaluate the various biologic prosthetic materials.

Patel and Bhanot 101 reviewed literature and provided perspective from their own practice relevant to the use of human or porcine acellular matrix materials in *Plastic and Reconstructive Surgery*, 2012. The authors cited data confirming that porcine products have a higher tensile strength after incorporation than human matrices, while human matrix materials tend to have better cellular infiltration and incorporation than the porcine products. Additional data supplied by the authors showed that non-cross linked matrices were associated with more efficient cellular infiltration and incorporation compared with cross-linked matrices. The authors offered the opinion that the widely variable reported recurrence rates might be the result of including incisional hernia repairs performed with a bridging (interlay) technique with repairs done after complete peritoneal and fascial closure with the matrix used as a reinforcement of the native tissue repair. The authors offered advice on maneuvers they used to prevent seroma formation, including the avoidance of large subcutaneous flap creation, complete excision of the hernial sac, suture closure of dead space areas, use of suction drains with delayed removal, and the use of postoperative abdominal binders. Measures they recommend to avoid laxity and recurrence include placing the prosthetic material under maximal tension, avoidance of excessive handling of the prosthesis, use of large (zero or #1) monofilament mattress sutures to secure the prosthesis, and ensuring at least a 5 cm of overlap of the prosthesis-fascial interface.

**Emergency Presentation of Incisional Hernias**

The diagnosis and management of urgent and emergency complications of incisional hernias are the topics of an article by Davies and coauthors 102 in *Annals of the Royal College of Surgeons of England*, 2007. The authors reported a prospective audit of patients requiring urgent or emergency surgical management of abdominal wall hernias over an interval of nine months in a single hospital in Great Britain: the authors found 55 patients that met inclusion criteria. Thirty-nine of these required emergency operation. Of these 39 patients, the average age was 77. Delay in referral for surgical consultation was the most common factor associated with both perioperative complications (43%) and the need for intestinal resection (15%). The authors recommend that all patients with symptomatic incisional hernias be referred for surgical evaluation. Patients who are older and have significant comorbid conditions are particularly vulnerable to the development of urgent complications of abdominal wall hernias.
A second article dealing with incarcerated incisional hernias is by Derici and coauthors in *Hernia*, 2007. These authors reviewed outcomes data on 182 patients. The data disclosed that delay of operation, older age, higher ASA score, and intestinal necrosis were all factors associated with perioperative complications and mortality. These authors also recommend that symptomatic incisional hernias should have urgent surgical consultation.

**Prosthetic Patch Infection Management**

Prosthesis infection is a dreaded complication of incisional hernia repair. Risk factors for developing these infections are discussed in an article by Kaafarani and coauthors in *Journal of Surgical Research*, 2010. These authors used data from a randomized prospective trial comparing open and laparoscopic incisional hernia repair to evaluate SSI risk factors within eight weeks after operation. The authors assessed patient factors (smoking, ASA score) and the effect of the operative approach. SSIs developed in 14% of patients. The patient factors were no different between patients who developed infection and who did not: because this was a Veterans Administration study dealing with older patients with significant comorbidities, this lack of a difference is not surprising. The authors found that the only factor associated with an increased infection risk on multivariate analysis was the use of open operative techniques.

A second article dealing with a larger patient sample from the Veterans Administration health system analyzes data on the risk of infection after incisional hernia repair. The article is by Finan and coauthors in *American Journal of Surgery*, 2005. These authors analyzed outcomes data from nearly 1,500 patients in the Veterans Administration health system. They found that patient factors were important drivers of wound infection: smoking, older age, obesity, emergency operation, and the use of absorbable prostheses were all associated with infection risk. The authors noted that emergency operation and the use of absorbable prosthesis probably indicate that the operation was performed on a high-risk patient.

SSIs may increase the risk of prosthesis explantation. This topic is the focus of an article by Hawn and coauthors in *American Journal of Surgery*, 2011. These authors analyzed outcomes data from more than 1,000 patients. They found that postoperative infection involving the implanted material was the main driver of explantation risk. Infection risk and explantation risk were higher in patients who had concomitant intestinal procedures at the time of prosthesis placement. Expanded polytetrafluoroethylene placement during an open operation increased the risk of infection of the prosthetic patch and subsequent explantation. The authors cited data supporting the fact that this type of prosthesis is less resistant to bacterial colonization and, once colonized, the material is more difficult to render sterile. Other than infection, the most common cause of prosthesis explantation was the need for a subsequent abdominal operation for intestinal obstruction.

A review of the diagnosis and management of prosthetic patch infection after incisional hernia repair is found in an article by Collage and Rosengart in *Surgical Infections*, 2010. The authors reviewed available data and recommended that systemic antibiotic prophylaxis be used perioperatively according to standard indications. This practice is recommended as an effective means of reducing the risk of prosthesis infection. Suspicion of prosthetic patch infection is aroused when there is wound tenderness and purulent drainage. Patients who have wound tenderness with no drainage and are febrile can undergo imaging with ultrasonography, CT, or MRI to determine the presence of fluid collections. Localized fluid collections can be aspirated for microbial culture as well as for therapeutic purposes. Systemic antibiotic therapy is begun and targeted based on culture results. Patients with continued symptoms can undergo collection drainage by opening the incision. Irrigation of the prosthesis may assist in clearing the infection. Continued purulent drainage and/or symptoms of infection indicate the need for removal of parts or all of the prosthesis. The article offers a helpful algorithm which is reproduced as Figure 8 with permission.
Repairing High-Risk Incisional Hernias with Biologic Prostheses

An article that reviewed the structural characteristics and cost data for prosthetic patches that could be used for incisional hernia repair is by Bachman and Ramshaw in *The Surgical Clinics of North America*, 2008. This article is supplied as a full-text reprint accompanying some formats of SRGS. The authors reviewed the mechanical characteristics of the abdominal wall and the structural, biologic response, and incorporation characteristics of available prosthetic materials. The authors concluded that there were no strong data supporting a recommendation of one prosthetic device over another, instead, they recommended that prosthesis choice be guided by patient characteristics (such as age and body habitus), risk factors, and whether contamination and/or infections are present. Readers are encouraged to review this article in detail.

A review of available data designed to provide guidance for surgeons faced with the challenging situation of managing a patient with an incisional hernia presenting in a high-risk wound (contaminated or infected) is by Primus and Harris in *Hernia*, 2013. The authors reviewed the available reports supporting the use of biologic matrix prostheses for high-risk incisional hernia repair. Based on their analysis they offered four observations: first, the available data are reported in articles that are small, retrospective case series or isolated case reports; second, the manner in which the data are reported is inconsistent across articles; third, all available articles support the use of acellular matrices for high-risk hernia repair, but a direct comparison of biologic to synthetic prostheses in this setting has not been done; finally, classification of wounds using a standard system (such as the CDC wound classification system) has not been included in any of the available studies. The authors...
concluded that, based on available data, it is not possible to confirm that biologic prostheses are more effective than synthetic prostheses for repairing incisional hernias in high-risk wounds.

Patients undergoing urgent or emergency operation, patients with an intestinal fistula complicating an open abdominal wound, and patients with infected prosthetic patches will frequently require abdominal wall reconstruction. Options for the management of these patients were reviewed in the article by Shankaran and coauthors (mentioned previously). These options include the placement of absorbable prosthetic material and planned reoperation, or the use of biologic prosthetic material.

**Dr. Fitzgibbons’ Pearl No. 4**

Novel materials have recently been introduced which integrate the desirable qualities of both biologic and synthetic mesh materials. Examples of such materials include Phasix® mesh (Davol, Warwick RI), which is a long term resorbable mesh composed of monofilament poly-4-hydroxybutyrate, and TiGR Matrix Surgical Mesh® (Novus Scientific), which is composed of fast and slow degrading synthetic resorbable fibers (Glycolide, lactide and trimethylene carbonate). These materials are gradually reabsorbed by the body in a predictable fashion. Preclinical in vivo and in-vitro studies have shown favorable results with these materials and further clinical evaluation is currently underway.

A common choice for the reconstruction of incisional hernias in contaminated fields is human acellular dermal matrix. Three articles are reviewed at this time that present clinical data on the use of this implant as an incisional hernia repair method: the first article is by Jin and coauthors in the *Journal of the American College of Surgeons*, 2007. These authors provided retrospective medical record data on 37 patients who had incisional hernia repair in high-risk contaminated fields. Acellular dermal matrix was used in all patients. Eleven patients underwent bridged repair where the prosthesis was sutured to the edge of the defect. The remaining patients had a components separation fascial closure reinforced with the biologic prosthetic material. The data disclosed that out of the 10 patients in the bridged group who were available for long-term follow-up (21 months), eight developed recurrences. The authors did not provide data on whether there was documented separation of the prosthetic patch from the fascia or whether the “recurrences” were eversion of the prosthesis without separation. Of the patients with prosthetic patch reinforcement, 20 were available for long-term follow-up, and four of these developed recurring hernias.

The second article reviewed is by Patton and coauthors in the *American Journal of Surgery*, 2007. The article supplied retrospective data on 67 patients who had human acellular dermal matrix repair of anterior abdominal wall defects following fistula takedown, abdominal catastrophe, or incarcerated incisional hernias. In this series, two patients required removal of the prosthetic material and 10 developed recurrent hernias. Fourteen patients developed wound infections, but most of these could be managed without removal of the prosthesis. The authors concluded that biologic material is a useful means of providing abdominal wall closure in high-risk fields.

The final article reviewed in this section of the overview is by Diaz and coauthors in *Archives of Surgery*, 2009. These authors provided retrospective outcomes analysis of a multicenter experience with human acellular dermal matrix for reconstruction of abdominal wall defects in high risk fields. More than 200 patient datasets were submitted. The hernia recurrence rate was 17%. The recurrence rate for intestinal fistula after fistula repair was an admirable 12%. The authors concluded that these data strongly suggest an important future role for biologic prosthetic patches in the repair of complex incisional hernias.

### Laparoscopic Incisional Hernia Repair

Heniford and coauthors reported outcomes data on 850 incisional hernias repaired laparoscopically in four surgical practice sites in *Annals of Surgery*, 2003. The authors also presented their surgical technique, which consists of establishing a pneumoperitoneum and placing a camera port remote from the hernia site; additional trocars are
placed and any adhesions are taken down; a prosthetic patch sized to overlap the sides of the hernia defect by 4 cm in all dimensions is fashioned, and 4–6 anchoring sutures are placed in the prosthesis; once the defect is fully visualized, the prosthetic patch is inserted and deployed; the sutures are passed through the abdominal wall and tied in the subcutaneous layer of small incisions in the anterior abdominal wall; finally, the edges of the prosthetic patch are secured with additional transabdominal wall sutures and laparoscopic tacks. The authors reported excellent perioperative outcomes, and the hernia recurrence rate of 4.7% is notable. They also found that obesity and the need to repair a recurrent hernia were both associated with an increased risk of hernia recurrence. The authors concluded that laparoscopic incisional hernia repair is associated with good outcomes and a low recurrence rate.

The excellent outcomes reported in the series by Heniford and colleagues were confirmed by a large metaanalysis of published experience by Carlson and coauthors\(^\text{14}\) in *Hernia*, 2008. The authors reviewed outcomes of published data of patients undergoing laparoscopic repair of incisional hernias. Outcomes data from more than 6,200 patients were reviewed. Operative mortality was 0.1%. Perioperative complication rates were 3% and the most frequent serious complication was intestinal injury. The overall hernia recurrence rate was reported to be 2.7%. The authors concluded that laparoscopic repair of incisional hernias is the procedure of choice for this condition if an experienced surgeon is available to perform the procedure.

Pham and coauthors\(^\text{15}\) presented a metaanalysis of available trials in *Surgical Endoscopy*, 2009. The authors identified six randomized controlled trials and eight non-randomized studies. The authors were not able to confirm that operating times were either longer or shorter with the laparoscopic approach. They noted that the studies of the laparoscopic approach generally reported operations on hernias of smaller size, since placement of laparoscopic ports in patients with very large defects is difficult. The studies of open prosthetic patch hernia repair that they reviewed are all notable for a very low hernia recurrence rate averaging 6%, which is somewhat lower than frequencies reported in other studies of open incisional hernia repair. Follow-up intervals were not regularly reported. Because of the low recurrence rates reported with open repairs in this analysis, there was no demonstrable difference in overall hernia recurrence rates for the laparoscopic repairs. The authors noted that recovery times may be shorter and pain levels lower with the laparoscopic approach.

Fixation of prosthetic patches placed for the laparoscopic repair of incisional hernias has been a topic of interest to surgeons. Anecdotal reports of hernia recurrence when tack fixation is used and intermittent reports of excessive pain with suture or tack fixation have raised concerns. Tack fixation is associated with shorter operative times. Suture fixation requires several small incisions on the anterior abdominal wall for suture tying in the subcutaneous space. In many of the articles reviewed previously, both suture and tack fixations were used.

A randomized prospective trial of three fixation methods is by Wassenaar and coauthors\(^\text{16}\) in *Surgical Endoscopy*, 2010. The authors randomized 199 patients and assigned patients to have fixation with absorbable sutures plus tacks, a double row of tacks with no sutures, and non-absorbable sutures with tacks. At follow-up intervals extending out to three months, patients were examined for recurrence and excessive pain. Recurrence was confirmed with ultrasound or axial imaging. There was no difference noted in baseline characteristics of patients, including age, body mass index (BMI), ASA score, and hernia size. At three months of follow-up there was no significant difference in pain scores. Quality of life scores showed a significant difference favoring tack fixation in only two categories: all of the other categories showed no significant difference. Recurrence was confirmed in 1.2% of patients at three months follow-up. Although this study is handicapped by a short follow-up and no blinding of caregivers who evaluated pain and hernia recurrence, the number of enrolled patients is relatively large and the conclusions clearly suggest no superiority of one fixation method over another.

A systematic review of the literature by Brill and Turner\(^\text{17}\) in the *American Surgeon*, 2011, analyzed 43 articles that compared prosthetic patch fixation methods. Outcomes of more than 8,500 patients are recorded, and the mean follow-up interval is nearly three years. This review confirmed the findings of the randomized prospective trial reported above, and again, no clear superiority of one fixation method over the others could be documented.
Five randomized trials enrolling more than 300 patients in total have been completed: each of these compared open and laparoscopic prosthetic patch repairs of incisional hernias. The studies included large defect hernias and complex incisional hernias of the lower abdomen after gynecologic operations. The trials confirmed that wound infection, postoperative pain persisting beyond one week, and patient satisfaction are all better in the groups assigned to laparoscopic repair. Overall complications were also generally fewer in laparoscopic repairs, although bowel injury continues to be recorded in laparoscopic repairs. Recurrence rates tended to be lower in laparoscopic repairs as well, although statistically significant differences in recurrence rates have not been confirmed.

Two meta-analyses of existing literature comparing laparoscopic with open incisional hernia repair have also been reported. These reviews contain data from a total of 18 trials. The data disclosed no significant difference in postoperative pain, but there is a trend toward shorter hospital stays and reduced SSIs with laparoscopic repair. Statistically significant differences in recurrence rates were not confirmed.

### Recurrent Incisional Hernia Management

Risk factors assessment and the development of recurrence prediction tools is the focus of two articles discussed at this time: the first article is by Kanters and coauthors in the *Journal of the American College of Surgeons*, 2012. The authors noted that the most commonly used risk score for prediction of SSO (infection or recurrent hernias) is the four-level Ventral Hernia Working Group score. In this system, grade 1 is assigned to patients with no history of wound infection and one or fewer comorbid conditions (smoking, diabetes, obesity). Grade 2 patients are patients with comorbid conditions, while grade 3 patients are patients with a history of infection; grade four patients are patients with an active infection, stomas, and/or intestinal fistulas. The working group recommended synthetic prosthetic patch repair for grade 1 patients and biologic prosthesis repair for grade 3 and 4 patients. No recommendation was made for grade 2 patients. The authors used the extensive information in their prospectively gathered incisional hernia database to reevaluate the surgical site occurrence (SSO) risk score. They concluded that a more accurate method was to convert to a three level system: in this proposed system, grade 1 would be assigned to patients with no history of infection and no comorbid conditions, while grade 2 would be assigned to patients with a history of wound infection and any single or combination of comorbid conditions, such as diabetes, COPD, history of smoking, or obesity. Grade 3 patients would be those judged to have clean contaminated, contaminated, or dirty wounds based on the CDC wound classification system. The scoring system is included here as Figure 9. Using their database, the authors estimated that the SSO risk would be 14% for grade 1, 27% for grade 2, and 47% for grade 3. They concluded with a recommendation that prospective trials be conducted using this system to stratify patients.

Berger and coauthors presented a review of data from their single-institution database in the *Journal of the American College of Surgeons*, 2013. They used standard methodology (regression, area under the receiver-operator curve) to validate several scoring variables in nearly 900 patients. They found that an accurate method of predict-
ing SSIs could be constructed using a system that awarded two points each for concomitant hernia repair, skin flap creation, and ASA score >3. Three points were awarded for BMI >40 and seven points were awarded for wound class 4 according to the CDC wound classification system. Prediction of SSO risk was accurately predicted by awarding two points for skin flap creation, concomitant hernia repair and prosthetic patch implantation and nine points for wound class 4. The authors recommended that this scoring system be used for preoperative patient counseling and stressed that independent validation is needed.

Another article that examined the impact of prior hernia repair operations on recurrence risk is by Holihan and coauthors in the Journal of the American College of Surgeons, 2015. The authors reported data analysis from a multicenter database involving nearly 800 patients seen over a 12-year interval. All included patients had follow-up intervals of at least 6 months. The authors found that the risk of reoperation rose linearly in relation to the number of prior repair attempts. The 10-year recurrence risk for incisional hernia repair was 64% overall. For patients who had had three prior repair attempts, the risk was 73%.

Laparoscopic repair of recurrent incisional hernias would seem logical, especially in patients who have undergone anterior prosthetic patch repair for the primary operation. An article supplying outcomes data for a clinical series using laparoscopic repair for recurrent incisional hernias is by McKinlay and Park in the Journal of Gastrointestinal Surgery, 2004. The authors reported data from a prospectively maintained surgical database. Outcomes in 69 patients with recurrent incisional hernias were compared with outcomes of 101 patients with primary hernia repair. The data disclosed that hernia size was larger in the recurrent group and operating time was longer. Of note is the fact that hernia recurrence with nearly two years of follow-up was similar in recurrent and primary hernia repairs (7% vs. 5%). The authors concluded that the laparoscopic repair method is useful for patients with recurrent inguinal hernias, particularly if the initial operation was an anterior open prosthetic patch repair.

Diastasis Recti, Epigastric Hernias & Umbilical Hernias

Diastasis recti is the term used to describe the widening of linea alba of the midline of the abdomen that can be a congenital condition affecting both men and women; the condition may also be a secondary phenomenon associated with pregnancy and childbirth in women or strenuous exercise in men and women. In some patients, protrusion of the widened area occurs with contraction of the abdominal wall muscles or when the patient stands. Diastasis recti does not carry a risk for incarceration or strangulation, and thus repair is usually chosen because of patient concerns over the appearance of the protrusion.

A systematic review of the literature that evaluated outcomes of operative procedures for diastasis recti is by Hickey and coauthors in Hernia, 2011. The authors evaluated 170 published articles and selected 16 as being appropriate for analysis. The authors noted that patients should be informed that the decision to perform a plication procedure for diastasis recti is driven by the patient’s concern over the appearance. Counselling is also necessary for patients who develop abdominal wall protrusion as associated with pregnancy because nonoperative therapies (exercise) may lead to resolution of the protrusion. The authors found that the techniques used in the included articles varied widely; open and laparoscopic approaches were used and various suturing patterns were employed. An important consideration is that plication of the rectus muscles and fascia may increase intraabdominal pressure to the point that breathing is altered and venous return is reduced. The data analysis showed that several articles reported high postoperative patient satisfaction, but none of the articles used a defined measurement tool to assess that satisfaction. The analysis also showed that complications were relatively common, and included seromas, hematomas, skin necroses, and wound infections. Recurrence rates also varied widely and ranged from 0% to 40%, with follow-up intervals extending out to 81 months. The authors emphasized that articles reporting low recurrence rates defined recurrence as the widening of the linea alba.
that was equivalent to the degree of widening that existed preoperatively: this definition introduced the hazard that small degrees of recurrence were not counted. The data analysis supported the conclusion that laparoscopic approaches were associated with lower complication rates than open approaches. The authors concluded that the decision to perform open or laparoscopic abdominoplasty for diastasis recti should be made cautiously since outcomes vary widely.

Epigastric hernias are defined as herniations of preperitoneal fat through a defect in the midline of the abdomen. Information on the prevalence of epigastric hernias was presented in an article by Burchart and coauthors in *Hernia*, 2015. The authors gathered data for a five-year interval beginning in 2006 from a national healthcare database involving nearly 6 million citizens. During this interval there were 2,412 repairs of epigastric hernias and 66% of these operations were performed on male patients. The data analysis showed that the highest 5-year age-specific prevalence for epigastric hernias, however, was 0.86%, and this was observed in female patients aged 40–50 years.

A review that presented information on the management of epigastric hernias is by Earle and McClellan in *The Surgical Clinics of North America*, 2013. National statistics for the United States cited in the review estimated that nearly 200,000 procedures were done to repair epigastric hernias in 2012. Earle and McClellan noted that the exact etiology of epigastric hernias is unknown. There are two main theories of causation and both may contribute to the development of epigastric hernias; one theory is that the hernia occurs in the space between perforating blood vessels and the surrounding fascia. Dissection studies cited by the authors have shown that a perforating blood vessel is frequently found in the peritoneal fatty tissue that is removed at the time of hernia repair. The second theory, reported in 1978 with data cited by the authors, hypothesized that the pattern of decussation in the fascia of the linea alba predisposed patients to epigastric hernias. Three patterns were identified: single decussations in the anterior and posterior layers of the rectus sheath and linea alba; single decussations in the anterior layer and triple decussations in the posterior layer; and triple decussations in both layers.

In the reported studies, epigastric hernias occurred only in patients who did not have triple decussations in at least one layer. Epigastric hernias occur in the midline between the umbilicus and the xiphoid process; epigastric hernias may present concomitantly with umbilical hernias, necessitating a strategy to repair both hernias if they are large and/or symptomatic. Earle and McClellan cited the classification system promulgated by the EHS. Epigastric hernias are classified according to location and size. Defects of 1 to 2 cm in diameter are termed small, while defects that are 2 to 4 cm in diameter are termed medium; defects >4 cm are termed large. The authors recommended primary suture closure of epigastric hernias that are 4 cm or less in size after excising the herniated properitoneal fat. Larger defects and epigastric hernias that are adjacent to umbilical hernias will frequently require prosthetic patch repair. Laparoscopic repair is infrequently needed in epigastric hernia procedures. The laparoscopic approach may be advantageous if multiple fascial defects are present.

Like inguinal hernias, umbilical hernias are commonly encountered in general surgery. The hernia may present with protrusion of the sac, which is sometimes associated with pain. Incarceration and strangulation of umbilical hernia contents is an unusual complication that may necessitate emergency hernia repair. More often, umbilical hernias gradually enlarge in patients with chronically increased intraabdominal pressure (pregnancy, obesity): these hernias can be particularly challenging to manage in patients with end-stage liver disease and refractory ascites—in this patient group, ulceration of the skin of the hernia with ascitic fluid leakage requires simultaneous efforts to reduce fluid leakage, reduce portal pressure, and manage the wound so that ascitic fluid infection is prevented. Patients with end-stage liver disease are high-risk patients for operation (management of complications liver disease was discussed in *SRGS*, Volume 38, Numbers 3, 4, and 5). In this section of the overview we will review the management of uncomplicated symptomatic umbilical hernias, as well as complicated umbilical hernias.

In their review Earle and McClellan noted that umbilical hernias may occur because of a weakness in the umbilical orifice or in the tissue surrounding the scar that fills the umbilical orifice in older children and adults. The
Diastasis Recti, Epigastric Hernias & Umbilical Hernias | HERNIA

authors emphasized that location of the round or falciform ligament over the umbilical orifice may protect against umbilical hernia formation. The authors emphasized that the decision to repair an umbilical hernia will be based on patient age, whether the protrusion is associated with pregnancy (which may resolve with time), the size of the defect, and the volume of intraabdominal content; patient preferences also need to be determined. One example presented by the authors is a patient with a relatively large hernia that was repaired laparoscopically. The patient was dissatisfied with the result because of the redundant skin that remained after the repair. Careful patient counselling was recommended.

Earle and McClellan noted that historically, a symptomatic umbilical hernia with a defect larger than 2.5 cm (two fingerbreadths) is repaired with a tissue closure using the traditional transverse vest-over-pants closure technique (positioning the upper fascial layer so that it overlaps the lower fascial layer by 2 to 3 cm and achieving closure with two rows of sutures from upper fascial layer to the lower fascial layer) or an in-line closure with non-absorbable suture. They noted that this technique was described by Mayo in 1911. Transverse closure takes advantage of the higher compliance of the abdominal wall when transverse closure is used. Because these techniques are closures under tension, fear of an increased recurrence risk has stimulated the use of prosthetic patches for closure of umbilical defects. The authors noted that closure with a prosthetic patch is useful for larger hernias. Available patches with collapsible rings can be placed through umbilical openings with intraperitoneal placement without enlargement of the umbilical opening. Once placed, the ring can reexpand, covering the entire defect with sufficient overlap to minimize recurrence risk. The authors noted that laparoscopic approaches to repair may be particularly useful for larger hernias. The falciform and round ligament tissue needs to be dissected away from the defect, and a prosthetic patch can be placed secured by tacks or sutures, although the authors recommended using both. With modern approaches, recurrence rates cited in the review ranged from 0% to 3% for prosthetic repairs and up to 14% for sutured repairs. Other complications included seromas, hematomas, and skin edge necroses.

Additional information on managing umbilical hernias was provided by Aslani and Brown in Hernia, 2010. These authors reported a systematic review of the literature. Randomized controlled trials and observational studies comparing prosthetic patch closure with suture closure were gathered. The authors identified more than 1,200 potentially eligible randomized trials and more than 4,200 potentially eligible observational studies. After screening articles for quality and consistency, three randomized trials and 10 observational studies were deemed eligible for inclusion in the systematic review. The authors found that prosthetic patch repair was associated with a significant reduction in risk of recurrence compared with suture repair in all studies of elective and emergency umbilical hernia repair. Perioperative complications were not increased when the two repair techniques were compared. Specifically, there was no increased SSI risk or progression to prosthesis infection in the studies of patch repairs. The authors noted that there are several methods of prosthesis placement, ranging from the use of a hernia plug to onlay of prosthesis over the defect, and suture of the prosthesis to the defect edges or to fascia surrounding the defect. The available studies did not disclose an identifiable advantage of one placement method over the other; extrapolating from experience with incisional hernias, onlay patch with use of the hernial sac to protect the underlying intraperitoneal contents would likely be the best choice. The authors further noted that the randomized trials and the observational studies did not systematically examine the effect of hernia size on the recurrence rate. Most of the observational studies were analyses of data in large databases and these studies were usually biased toward the use of prosthetic patch repair in larger hernias; this fact would actually serve to strengthen the conclusion that prosthetic patch repair is associated with a reduced rate of umbilical hernia recurrence. The authors concluded by noting that all included studies had follow-up periods of sufficient length to discover at least 75% of recurrences, since available data indicate that most recurrences of umbilical hernias happen within one year of the primary repair operation.

The next article reviewed presents a before-and-after study design comparing the onlay prosthesis technique with the intraperitoneal “underlay” technique for repair-
ing umbilical hernias 3 cm diameter or less: the article is by Berrevoet and coauthors in the American Journal of Surgery, 2011. The authors provided outcomes data for 56 consecutive patients who underwent umbilical hernia repair using an onlay patch technique (3 cm overlap of the prosthesis on the defect in all directions with the patch sutured to the fascia of the abdominal wall using absorbable suture). These patients were compared with a subsequent group of 60 consecutive patients who had hernia repair with an intraperitoneal memory ring device placed through the defect into the peritoneal cavity and deployed: anchoring straps facilitate positioning of the prosthesis, and the prosthetic material overlaps the posterior fascial surface by 2.5 cm in all directions; the anchoring straps are sutured to the fascia at the site of the hernia defect. The authors found that operating time, perioperative pain, and hospital lengths of stay were reduced with the use of the intraperitoneal device. Unfortunately, there were nearly three times as many recurrences within the first 12 months with the intraperitoneal hernia ring device than with the alternative technique. The authors cautioned that the higher recurrence rate (the difference was not statistically significant) suggests that the intraperitoneal device should be used with caution, even though the device is easy to place and associated with less perioperative pain.

Another hernia prosthesis device amenable for use in umbilical hernia repair is the Prolene hernia system™. A report analyzing data from a prospective randomized trial comparing the use of this device for umbilical hernia repair with tissue (vest over pants) repair and prosthetic patch onlay repair is by Polat and coauthors in the American Journal of Surgery, 2005. A small number of patients were randomized to each group (17 to 19 patients). The analysis disclosed that perioperative pain and analgesic use was less in the patients who had repair using the Prolene hernia system™. Recurrences (N=2) were seen only in the tissue repair group in a follow-up interval of nearly two years. The authors concluded that the hernia system repair technique was feasible and safe.

Laparoscopic repair of umbilical hernias may be particularly useful in morbidly obese patients. An article that provides data on 10 consecutive morbidly obese patients (BMI mean of 34 kg/M²) who underwent laparoscopic single port repair of umbilical hernias is by Roberts and coauthors in Surgical Innovation, 2010. The authors described a technique using a single laparoscopic port placed in the left upper quadrant of the abdomen: a circular prosthetic patch with pre-placed sutures was positioned over the defect and the sutures were placed into the fascia using intracorporeal suturing technique. The authors did not provide any information regarding hernia defect size or follow-up data. Only one postoperative complication occurred (urinary retention). Readers are encouraged to seek additional supporting data for this potentially valuable method of managing morbidly obese patients with umbilical hernias.

Managing umbilical hernias in cirrhotic patients with ascites is challenging. We will review two articles that offer guidance for effectively managing these patients. The first article is by Fagan and coauthors in Surgery, 2004. The authors provided two case reports of patients with ascites and fluid leakage from eroded skin over the umbilical hernia. Ascites control was achieved with transjugular intrahepatic portal venous shunts (TIPS). Occlusive dressings were used to control the wounds and elective repair was accomplished. The authors noted that control of ascites is essential in order to avoid hernia recurrence. They cited data indicating a hernia recurrence rate of 79% in patients where ascites could not be controlled. They further noted that control of ascites with peritoneal-venous shunting was effective in controlling ascites, but that the device was associated with a high complication rate and the need for shunt removal. Currently, the success of the TIPS procedure makes it the method of choice for controlling ascites in patients who cannot be controlled with medication and/or paracentesis. The authors mentioned that outcomes for elective repair of umbilical hernias in Childs class A and B patients have improved, and reported mortality rates of 2% or less are now common; data supporting this assertion were presented by the authors, and they suggested that aggressive control of ascites and elective hernia repair are preferable in this patient group.

A systematic review of the literature confirming the recommendations made by Fagan and coauthors was presented in a report by McKay and coauthors in Hernia, 2009. The authors conducted a systematic review of the literature from 1980 to 2007. The authors also surveyed surgeons to assess attitudes and approaches to the man-
agement of complicated umbilical hernias in cirrhotic patients. The survey results estimated mortality for repair of complicated umbilical hernias in cirrhotic patients as 25–30% for Child’s class A and B patients. The survey results indicated that most surgeons would electively repair an umbilical hernia in a Child’s class A patient, but that the survey respondents were reluctant to operate on Child’s B and C patients. Analysis of the systematic literature review disclosed that reported mortality rates for hernia repair in Child’s A and B patients now average 2.7%. The analysis confirmed that control of ascites using medical therapy or TIPS procedure was essential to the success of hernia repair. The authors concluded that elective umbilical hernia repair after successful control of ascites is an effective strategy for Child’s A and B patients. TIPS is an effective means of controlling ascites. Managing leaking ascites with sterile dressings while ascites control is achieved is safe and allows hernia repair to be delayed until the patient is stable.

Emergency repair of umbilical hernias may be necessary when acute incarceration occurs or intestinal necrosis accompanying the incarceration is suspected. Earle and McClellan noted that open repair with prosthetic patch placement is the recommended approach to hernia incarceration unless intestinal resection is necessary. When intestinal necrosis necessitating resection is present, the risk of prosthetic patch infection is very high and thus suture repair or placement of a biologic patch are useful alternatives. Hernia recurrence may necessitate repeat operation and patients need to be informed of this risk.

Methods to prevent parastomal hernias have included placement of the stoma through the anterior and posterior rectus sheath with the stoma passing through the substance of the rectus muscle. Recently, prophylactic retrorectus preperitoneal prosthetic patch placement has been suggested as a means of preventing parastomal hernias in patients who will require a permanent stoma. Approaches to the repair of parastomal hernias have included simple relocation of the stoma with suture closure of the hernia defect after excision of the hernial sac; however, reported clinical series have disclosed that this approach is associated with a high risk of parastomal hernia development at the new site as well as a high risk of incisional hernia development at the site of the parastomal hernia repair. In addition, scarring from multiple abdominal operations and abdominal wall damage due to radiation therapy may limit the potential sites for relocation. A review article dealing with parastomal hernias is by Israelsson in Surgical Clinics of North America, 2008. The author noted that parastomal hernia classification systems have been based on the location of the hernial sac. These systems have not been useful clinically because of the difficulty in accurately determining sac location on physical examination. Israelsson suggested that parastomal hernias be diagnosed whenever there is a palpable fascial defect or a noticeable bulge in the area of the stoma found on palpation or visible when the patient coughs or strains. Any protrusion of abdominal contents through a defect observed on CT imaging should be termed a parastomal hernia. The author recommended that any of these findings occurring at a minimum follow-up of 12 months should be termed a parastomal hernia.

Parastomal Hernias

SRGS, Volume 41, Number 4 includes a review of articles on parastomal hernias. This current issue’s associate editor, Dr. Fitzgibbons, has recommended additional articles on this subject that will be presented at this time.

Parastomal hernias following the creation of a diverting intestinal stoma or the creation of an ileal conduit stoma for urinary diversion can result in stoma obstruction or leakage of stoma content due to poor fit of the stoma appliance. The incidence of parastomal hernias in the articles to be reviewed subsequently is substantial.

Incidence of & Risk Factors for Parastomal Hernias

Israelsson noted that the reported incidences of parastomal hernias range from 5% to 52%. This wide range is probably the result of varying diagnostic techniques used in the articles cited in the review. Studies used CT imaging to diagnose parastomal hernia were more likely to report higher incidences of this condition.
Additional data on the incidence of and risk factors for parastomal hernias were reported in an article by Kouba and coauthors in the Journal of Urology, 2007. These authors reviewed retrospective medical record data on 137 patients who underwent permanent stoma formation for urinary diversion. All patients were observed for at least one year and the incidence of complications, including parastomal hernias, was recorded. Various risk factors were examined, including BMI, a history of smoking, and a history of abdominal wall damage from radiation therapy. The authors found that parastomal hernias occurred in 14% of patients. The only significant risk factor for development of parastomal hernias was a BMI in the obese range or higher (BMI>30 kg/m²).

Another article providing data on the incidence of parastomal hernias was by Pilgrim and coauthors in Diseases of the Colon and Rectum, 2010. These authors prospectively observed 90 patients after formation of a permanent intestinal stoma for fecal diversion. The overall rate of parastomal hernias for patients observed for at least two years was 33%. Parastomal hernias occurred more often after colostomy than ileostomy. Parastomal hernia risk increased with the increasing diameter of the stoma passage pathway through the abdominal wall. This report also found that older age was a significant risk factor for parastomal hernias; other factors, such as obesity, did not significantly increase risk.

Preventing Parastomal Hernias

Israelsson noted that maneuvers designed to prevent parastomal hernia formation have included placement of the stoma through the rectus muscle. Review data cited reductions of parastomal hernia risk when stomas are placed through, rather than lateral to, the rectus muscle. The author cautioned that stomas should not be placed in the surgical incision because of the risk of parastomal hernias, wound infections, and wound dehiscence. Additional data cited by the author suggested that creation of the stoma using a trephine device was associated with a reduced risk of parastomal hernias. He cautioned that these data were reported after a relatively short follow-up, and that the reduced risk might not be observed over longer follow-up intervals. Israelsson recommended that the abdominal wall opening made to accommodate the stoma should be as small as possible.

Prevention of parastomal hernias with prophylactic prosthetic patch placement at the stoma site was reviewed in SRGS, Volume 42, Number 4. A systematic review of the literature relevant to this technique is by Shabbir and coauthors in Colorectal Disease, 2012. The authors found three acceptable studies from a total of 27 studies reviewed, and all of these were prospective randomized trials involving a total of 128 patients. Although the number of trials and included patients was small, the data support a significant reduction in the rate of parastomal hernia with prophylactic prosthesis placement.

Additional data on this technique was reported in an article by Marimuthu and coauthors in Colorectal Diseases, 2006. The authors reported outcomes for 18 consecutive patients observed for at least six months after creation of a permanent intestinal stoma with prophylactic placement of a prosthetic patch in a retrorectus, preperitoneal onlay position with an opening for the intestine created in the prosthetic patch. These authors performed the preperitoneal space dissection for placement of the prosthesis from inside the peritoneal cavity and used a nonabsorbable prosthetic patch that was 6 x 6 cm in size. Over the course of follow-up, the authors reported one episode of stomal necrosis managed without removal of the prosthesis, and no instances of parastomal hernia or prosthesis infection were observed.

The next article reviewed is by Isrealsson in the World Journal of Surgery, 2005. In this review article, the author referred to a randomized prospective trial involving 54 patients who were randomized to receive a permanent diverting intestinal stoma formed via a transrectus muscle pathway or a similar stoma with a 6 x 8 cm prosthetic patch placed in a preperitoneal, retrorectus position with the intestinal conduit passed through an opening in the prosthesis. Isrealsson reported that the trial had to be halted because the parastomal hernia rate was significantly lower in the patients receiving prophylactic prosthesis. No prosthesis infections occurred and the prosthesis did not have to be explanted because of bowel erosion. The
The author ascribes the success of this approach, at least in part, to the use of low-weight prosthetic material with a large pore size.

An article describing use of preventive prosthesis placement in elective as well as emergency stoma formation is by Janes and coauthors in the *World Journal of Surgery*, 2010. These authors reported outcome data on 73 patients who had preperitoneal retrorectus prosthetic patch placed with passage of the intestine through and opening in the prosthesis. The authors focused on a group of 16 patients who had purulent peritonitis and/or fecal contamination of the peritoneal cavity. There was no instance of prosthesis infection or bowel erosion by the prosthesis. Overall, the incidence of parastomal hernia in patients who received prosthesis placement was 13%, compared with 67% in patients who did not receive a prosthetic patch. The authors concluded that preventive prosthesis placement is safe and effective, even in an emergency operation setting with purulent peritonitis or fecal contamination.

A final article reporting data on the use of biologic prosthesis for parastomal hernia prevention is by Hammond and coauthors in *Hernia*, 2008. This small, randomized prospective trial assigned 10 patients to receive conventional stoma formation and 10 to receive stoma formation with preperitoneal, retrorectus placement of porcine collagen patch. Over a short follow-up period of six months, no patient in the prosthesis group developed a parastomal hernia, while three patients in the conventional group developed a parastomal hernia. The authors concluded that, along with potentially reducing prosthesis infection risk, biologic prosthesis insertion is an effective method of parastomal hernia prevention; still, these results should be interpreted with caution because of the short duration of the follow-up interval.

**Open & Laparoscopic Repairs of Parastomal Hernias**

Several techniques of parastomal hernia repairs were discussed in *SRGS*, Volume 41, Number 4. Additional information is provided in the review article by Isrealsson: in this article, the author described his technique for managing a parastomal hernia. The approach consists of relocating the stoma to another quadrant of the abdomen; the peritoneal cavity is entered via a midline incision and the parastomal hernia sac is excised, leaving enough to provide a peritoneal closure at the hernia site; a preperitoneal retrorectus space is created on each side of the midline incision to permit placement of a prosthetic patch that will overlay the site of the parastomal hernia with a 3-cm overlap after the peritoneum is closed; the space is extended to permit placement of the prosthesis over the site of the newly relocated stoma, so that the intestine can be passed through the prosthetic patch. The author reported a personal series of 13 patients treated by this method without development of parastomal hernias in any patient over long term follow-up.

Another article describing experience with preperitoneal onlay prosthesis repair of parastomal hernias is by Luning and Spillennaar-Bilgen in *Hernia*, 2009. These authors reported retrospective medical record data on 16 patients with parastomal hernias treated at a single center in a 10-year interval. Each hernia was repaired with preperitoneal onlay prosthetic patch. Over long-term follow-up, patch removal was necessary in one patient (6%) and the recurrence rate for incisional hernias at the repair site was 19%. The authors concluded that preperitoneal prosthetic patch is an effective approach for managing parastomal hernias.

A meta-analysis of available data relevant to laparoscopic techniques for repair of parastomal hernias was published by DeAsis and coauthors in the *World Journal of Gastroenterology*, 2015. The authors gathered data from 15 studies that included 469 patients. Two techniques were reviewed: the laparoscopic keyhole technique, where an intraperitoneal prosthetic patch is placed, with the bowel brought out through a small opening in the prosthetic material; and the laparoscopic modification of the Sugarbaker technique, where a prosthetic patch is placed with the stoma site left in its original position—the prosthetic patch is placed intraperitoneally and the bowel is led out through an opening at the edge of the patch. The data analysis showed that the modified Sugarbaker technique was associated with a significantly lower rate of hernia recurrence (10.2% vs. 27.9%) compared with the keyhole technique. Operative morbidity was similar for the two techniques.
Laparoscopic approaches to parastomal hernias were described in two articles reviewed in this section of the overview: the first article described experience with the laparoscopic-modified Sugarbaker technique, with the prosthetic patch sutured to the serosa of the intestine at the exit site from the lateral aspect of the prosthetic patch. The article describing experience with this approach is by LeBlanc and coauthors in Hernia, 2005. The authors performed this repair in 12 consecutive patients using an expanded polytetrafluoroethylene patch. Over a follow-up period that averaged nearly two years, the authors noted one recurrent hernia and encountered no instances of bowel erosion or prosthesis infection.

The second article described a technique where the prosthesis is applied to the abdominal wall to cover the hernia defect, and then the material is wrapped around the intestine to create a funnel-shaped repair. Experience with this approach is described in an article by Hansson and coauthors in Surgical Endoscopy, 2007. The authors reported experience with 55 patients. The laparoscopic patch repair was successfully completed in 43 patients; no deaths occurred. Bowel wall damage occurred in four patients, but no prosthetic patch removal was necessitated. Over a short follow-up period of six weeks, one recurrence was noted.

A consensus statement based on expert opinion from a multidisciplinary group including surgeons, a musculoskeletal radiologist, and a physiotherapist was published in an article by Sheen and coauthors in the British Journal of Sports Medicine, 2014. The authors stressed that there has been no clear consensus on the etiology or the most typical clinical features of patients who have chronic groin pain due to sports participation. They further noted that many elite and average athletes are afflicted with groin pain; such pain is most common in patients who participate in sports that require jumping, kicking, and twisting, and is less common in cycling and swimming. The pain is most commonly felt at the junction of the insertions of the rectus abdominis muscle, the adductor longus tendon, and the inguinal ligament into the pubic bone. The authors recommended a careful history and physical examination and selective use of imaging studies such as ultrasonography and MRI to exclude other conditions that can cause similar pain, such as osteitis pubis, adductor muscle injuries, and pubic symphysitis.

The consensus statement recommended that the appropriate term for this condition would be “inguinal disruption” (ID); ID symptoms would include groin pain of an acute or insidious onset occurring predominantly in the groin area. To support a clinical diagnosis of ID, at least three of the following symptoms should be present: 1) pinpoint tenderness over the pubic tubercle at the point of insertion of the conjoint tendon; 2) palpable tenderness over the internal inguinal ring; 3) pain and/or dilation of the external inguinal ring with no obvious hernia; 4) pain at the origin of the adductor longus tendon; and 5) dull diffuse pain in the groin, often radiating to the perineum and inner thigh or across the midline. The consensus group agreed that the underlying pathology is weakening of the posterior layers of the inguinal canal. This pathology can be observed in up to 85% of patients who undergo operative therapy for ID. Observed abnormalities include tears in the external oblique aponeurosis and tears in the inguinal ligament. The authors emphasized that other findings are often present concomitantly and these include dilation of the inguinal ring, conjoint tendon tears, and inguinal ligament dehiscence. The consensus document recommended complete history and physical examination by members of a multidisciplinary team.
Inguinal Pain in Athletes | HERNIA

with MRI being the recommended approach if further confirmation is needed: common MRI findings included diffuse bilateral edema in the groin areas (more common in younger athletes) and focal edema in the symphysis and joint capsule areas (more common in older athletes). The consensus group agreed on a non-operative approach to treatment that includes: an interval of rest and analgesia followed by a program of rehabilitation (which includes range of motion and strength testing), and a defined education program that introduces a specific exercise program directed toward strengthening abdominal wall muscles, gluteal muscles and upper muscles of the lower extremity; the final non-operative approach phase is a training program that includes prescribed strengthening exercises, swimming, and yoga.

Surgical intervention was recommended if symptoms were not controlled after a two-month rehabilitation program. The surgical approaches were designed to relieve tension on the inguinal ligament by opening the external oblique and internal oblique muscle layers and dividing the inguinal ligament. These maneuvers would obviously create conditions for inguinal herniation and the surgical procedure would need to include a plan to reinforce the floor of inguinal canal. There were four surgical approaches discussed: a tissue-based open inguinal hernia repair (Shouldice technique), an open inguinal prosthetic patch hernia repair (Lichtenstein procedure), laparoscopic transperitoneal placement of a prosthetic patch, and total extraperitoneal endoscopic placement of a prosthetic patch. The consensus group acknowledged that there was not strong evidence to support one procedure over another, and surgeon expertise would necessarily be the main determinant of the chosen procedure.

An examination of the evidence supporting treatment plans for ID was published in an article by Serner and coauthors in the British Journal of Sports Medicine, 2015. The authors conducted a systematic review of the literature relevant to ID management starting in 1985. A total of 72 articles were included in the analysis, and only 6% of published studies were deemed to be of high quality. The available studies provided moderately strong evidence supporting a multidisciplinary approach using physical therapy assessment and a prescribed exercise program. For patients referred for surgical therapy, there was moderately strong evidence supporting the use of adductor tenotomy for patients and clear causal evidence of adductor longus muscle abnormality. There was weak to moderate evidence in support of most available surgical approaches that were used when nonoperative approaches failed. No evidence was available supporting one surgical approach over another.

Additional information was presented in a review article by Diesen and Pappas in Advances in Surgery, 2007. The authors stressed that groin pain in athletes can be caused by a variety of skeletal conditions, muscle and tendon tears, and an actual inguinal hernia. The proportion of patients presenting to sports medicine clinics with groin pain that leads to a sports hernia diagnosis ranges from 0.5% to 6.2%: most of patients diagnosed with sports hernias are high-performance male athletes, and soccer, hockey, and football are the most common sports associated with a sports hernia diagnosis. Although women athletes complain of inguinal pain, the symptoms can usually be traced to specific causes, such as endometriosis, menstrual pain, gastrointestinal disease, or inguinal/femoral hernia. Diesen and Pappas emphasized that the pathogenesis of inguinal pain in athletes leading to the diagnosis of sports hernia consists of tears or avulsions in the insertion of the rectus abdominis at the pubic symphysis. Tears in the insertion of the adductor muscles at the inferior border of the pubic symphysis also occur; tearing and disruption of the insertion of the transversus abdominal muscle can another cause of groin pain related to sports activity; weakening of the transversalis fascia and laddering tears of the external oblique muscle are also encountered. The authors noted that the commonly encountered adductor tears can be confirmed by the presence of adductor weakness. They also added that while other authors have postulated entrapment of the ilioinguinal nerve as a cause of inguinoodynia in athletes, ilioinguinal release operations are not uniformly successful in relieving the pain symptoms. Although some patients can identify a specific injury, less than one-third of patients are able to identify a specific time of injury. Some patients complain of a tearing or popping sensation. Physical examination discloses pain on adduction of the thigh, inguinal tenderness (especially in the area of the pubic symphysis), and internal inguinal ring.
Diesen and Pappas noted that one large series reported by Meyers and coauthors in *Annals of Surgery*, 2008, proposed a comprehensive surgical approach to strengthening the pelvic floor. The clinical series authored by Meyers and colleagues was presented to the plenary session of the 2008 meeting of the American Surgical Association. Meyers and associates reported a retrospective medical record review of nearly 8,500 patients seen over a 20-year time span. During this interval, over 5,000 operations were performed for pain treatment. The authors noted that MRI has become very valuable as a means of localizing the area of injury and planning operative strategy. They observed that the mean age of patients presenting with inguinodynia had increased over the interval of the analysis; the proportion of women patients increased to 15%, though Meyers and associates cited data from other studies suggesting a proportion of women patients of approximately 8%. Meyers and colleagues classified 82% of their patients as high-performance athletes. Operations performed included repairs of rectus muscle and tendon tears and adductor muscle and tendon tears. The most common postoperative complications were hematomas, dysesthetic pain, and venous thrombosis. Overall, more than 95% of patients experienced relief and the ability to return to competitive sports.

Another systematic review of the literature relative to inguinodynia in athletes was presented in an article by Caudill and coauthors in the *British Journal of Sports Medicine*, 2008. Caudill and colleagues stressed the importance of careful clinical examination and MRI to localize the area(s) that will require repair. They noted that laparoscopic approaches permit complete evaluation of the pelvic floor bilaterally, so that complete repairs can be achieved. Laparoscopic repair procedures are also associated with shorter recovery times and a faster return to competitive sports; the systematic review compiled by the authors confirmed a return to competitive sports in more than 92% of patients undergoing operation for ID.

A randomized trial of a laparoscopic approach to ID is by Paajanen and coauthors in *Surgery*, 2011. In this trial, a group of 120 patients with a clinical and/or MRI diagnosis of ID were randomized to receive laparoscopic extraperitoneal exploration of the pelvic floor with insertion of a prosthetic patch that covered the myopectineal orifice and the areas of rectus muscle and adductor muscle insertion at the level of the pubic symphysis bilaterally. Conservatively treated patients received comprehensive pain management, physical therapy, and a closely supervised rehabilitation program. Analysis disclosed that by 12 months after operation, 97% of patients treated laparoscopically had returned to competitive sports, compared to 50% of patients treated conservatively. The authors concluded that laparoscopic treatment of inguinodynia is effective, associated with a rapid recovery and a very high level of success in returning patients to sports participation.
This concludes our review of surgical hernia management. I hope that you will find this information valuable to your practice. The next issue of SRGS will be devoted to a review of general surgical topics pertinent to rural surgery; the associated editors for this issue are Don Nakayama, MD, FACS and David Borgstrom, MD, FACS. I welcome you to join us for that discussion.

Thanks for reading SRGS!

Lewis Flint, MD, FACS
Editor in Chief


References | HERNIA


REFERENCES


References


1. **The most common groin hernia diagnosed in women is which of the following?**
   a) Femoral hernia
   b) Indirect hernia
   c) Direct hernia
   d) Pantaloon hernia
   e) Patent processus vaginalis

2. **Data from Denmark reported by Burcharth and coauthors documented a bimodal distribution of inguinal hernia. The second peak incidence was in which age range?**
   a) 75–80 years
   b) 35–40 years
   c) 50–60 years
   d) 20–30 years
   e) 85–95 years

3. **The article by Koch and coauthors reported that the risk of reoperation after primary inguinal hernia repair was three times higher in women compared with men. The most common reason for reoperation was which of the following?**
   a) Wound infection
   b) Recurrent indirect hernia
   c) Recurrent direct hernia
   d) Prosthetic patch infection
   e) Femoral hernia that was not diagnosed at the primary operation

4. **The origin of the inferior epigastric artery is from which of the following arteries?**
   a) Superficial femoral artery
   b) Inferior mesenteric artery
   c) Common iliac artery
   d) External iliac artery
   e) Internal iliac artery

5. **All of the following nerves are located in or adjacent to the inguinal canal except which one?**
   a) Genitofemoral nerve
   b) Ilioinguinal nerve
   c) Femoral nerve
   d) Iliohypogastric nerve
   e) Lateral femoral cutaneous nerve

6. **According to data reported by Fitzgibbons and coauthors, the most common reason for a patient with an inguinal hernia to choose operation after an interval of watchful waiting is which of the following?**
   a) Hernia incarceration
   b) Development of strangulated hernia
   c) Enlargement of the hernia
   d) Development of a hernia on the opposite side
   e) Increased pain in the area of the hernia

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7. According to data reported by Chung and coauthors, the percentage of patients who choose hernia repair over watchful waiting during long-term follow-up is which of the following?
   a) 23%
   b) 70%
   c) 3%
   d) 14%
   e) 43%

8. According to the article by Abi–Haidar and coauthors, the mortality for an elective hernia repair in their patient cohort was 0.1%. The mortality for an urgent or emergency operation for complications of a groin hernia was which of the following?
   a) 4%
   b) 23%
   c) 9%
   d) 1.7%
   e) 16%

9. In the original description of the Bassini hernia repair, the conjoint tendon and the lateral border of the rectus fascia are sutured to which of the following structures?
   a) Inguinal ligament
   b) Cooper ligament
   c) Transversalis fascia
   d) Cremaster muscle
   e) Superior surface of the pubic bone

10. Potential disadvantages of laparoscopic groin hernia repair include all of the following except which one?
    a) Prolonged learning curve
    b) Increased cost
    c) Longer operative time
    d) Cannot be used for recurrent hernia repair
    e) Need for general anesthesia

11. According to data cited in the Clinical Practice Guidelines promulgated by the Society for Surgery of the Alimentary Tract, ventral hernia recurrence following native tissue repair is reported to be which of the following?
    a) 7%
    b) 5%
    c) 35%
    d) 50%
    e) 78%

12. In the article by Israelsson and Milbourn, optimum prevention of incisional hernias can be achieved by using a midline abdominal closure technique that employs a suture length to wound length ratio of which of the following?
    a) 2:1
    b) 1:1
    c) 10:1
    d) 12:1
    e) 4:1

13. Data reported in the article by O’Halloran and coauthors confirmed that ventral/incisional hernia recurrence following components separation plus prosthetic patch reinforcement is which of the following?
    a) 50%
    b) 1.7%
    c) 11%
    d) 34%
    e) 15%

14. According to data reported by Petro and coauthors, the most common cause of hernia recurrence after repairing incisional hernias with lightweight prosthetic material is which of the following?
    a) Prosthetic infection
    b) Prosthetic extrusion
    c) Structural failure of the prosthesis
    d) Prosthesis shrinkage
    e) Failure of suture material
15. All of the following are associated with an increased risk of complications and mortality after urgent or emergency repair of ventral/incisional hernias except which one?
   a) Older age
   b) Delay of operation
   c) ASA score of 3 or higher
   d) Intestinal necrosis
   e) Female gender

16. In the review by Earle and McClellan, the decision to repair an umbilical hernia is based on all of the following except which one?
   a) Patient age
   b) Hernia size
   c) Whether the hernia is associated with a recent pregnancy
   d) A history of diabetes
   e) The volume of intestinal and omental tissue within the hernia

17. The vest-over-pants technique for repairing umbilical hernia defects was described in 1911 by which of the following surgeons?
   a) Halsted
   b) Cushing
   c) Mayo
   d) Matas
   e) Bowditch

18. According to data reported by DeAsis and coauthors, the recurrence rate following the “keyhole” prosthetic patch repair of parastomal hernias is which of the following?
   a) 2%
   b) 27.9%
   c) 55%
   d) 8%
   e) 38%

19. Inguinal pain in athletes is least commonly encountered in which of the following sports activities?
   a) Football
   b) Soccer
   c) Rugby
   d) Swimming
   e) Basketball

20. Current expert consensus recommends which of the following imaging approaches for athletes with inguinal pain?
   a) Plain radiographs of the pelvic
   b) Contrast enhanced CT imaging
   c) PET–CT imaging
   d) MRI
   e) Ultrasonography

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   a) Strongly agree
   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree

22. The content was relevant to my educational needs and practice environment.
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   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree
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   b) Agree
   c) Neutral
   d) Disagree
   e) Strongly disagree

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   c) Neutral
   d) Disagree
   e) Strongly disagree

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   Burchart J, Pommergaard HC, Rosenberg J
   Burcharth and colleagues review evidence for inheritance of inguinal hernia. While some evidence supports an increased risk of inguinal hernia in patients with inherited connective tissue diseases such as Ehlers-Danlos syndrome the evidence of other familial pathways for hernia inheritance is mixed.

2. Crucial steps in the evolution of the preperitoneal approaches to the groin: an historical review...0-0
   Read RC
   Read offers a valuable review of historical events that contributed to our knowledge of the anatomy of the preperitoneal space and myopectineal orifice.

3. European Hernia Society guidelines on the treatment of inguinal hernia in adult patients...0-0
   Clinical practice guidelines for management of inguinal hernia are reviewed in this article.

4. Open “tension-free” repair of inguinal hernias: the Lichtenstein technique...0-0
   Amid PK, Shulman AG, Lichtenstein IL
   This classic article provides a clear description of the technical steps of the Lichtenstein hernia repair.

5. Giant prosthetic reinforcement of the visceral sac. The Stoppa groin hernia repair...0-0
   Wantz GE
   Wantz provides a valuable review of the open preperitoneal approach for treatment of bilateral inguinal hernias. A unilateral variant of this approach is also useful for selected patients.

6. Classification of primary and incisional abdominal wall hernias...0-0
   Muysoms FE, Miserez M, Berrevoet F, et al.
   A classification system for abdominal wall hernias is described in this article.

7. Prevention of incisional hernias: how to close a midline incision...0-0
   Israelsson LA, Millbourn D
   This article describes a technique of midline abdominal incision closure that may prevent incisional hernias.

8. A single institutional comparison of endoscopic and open abdominal component separation...0-0
   Azoury and colleagues describe an innovative endoscopic approach to components separation for repair of ventral/incisional hernias.

9. Prosthetic material in ventral hernia repair: how do I choose?...0-0
   Bachman S, Ramshaw B
   This review article presents data supporting the appropriate use of prosthetic material for repair of ventral/incisional hernias.
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