



Femoral hernia repair

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Femoral hernia is not as common as inguinal hernia. It is often associated with incarceration or strangulation, resulting in peritonitis and mortality. There are three major approaches to femoral hernia repair, each with its own advantages and disadvantages. In the first section of this article, general aspects of femoral hernia, including anatomy, etiology, incidence, diagnosis, and history of surgical technique, are reviewed. In the second section, my strategy for treating femoral hernias, including operative techniques and its results, is discussed.

Anatomy

The pelvicular interval (the opening from the abdomen to the thigh) is divided into two spaces: a lateral space, the lacuna musculosa, through which the iliopsoas muscles pass; and a medial space, the lacuna vasculosa, for the femoral vessels [1]. The external iliac vessels run along the anterior surface of the iliopsoas muscle in the pelvis, pass between the iliopubic tract and Cooper's ligament, and finally course beneath the inguinal ligament to become the femoral vessels. Where the external iliac vessels run down into the lacuna vasculosa, transversalis fascia covers the vessels to form the femoral sheath. It extends approximately 4 cm caudally and ends as the adventitia of the femoral vessels. The medial compartment of the femoral sheath is called the femoral canal, which is ordinarily less than 2 cm in diameter and contains lymphatic vessels and glands [2]. The true opening of the femoral canal is a musculoaponeurotic ring, consisting of Cooper's ligament inferiorly, the femoral vein laterally, and iliopubic tract superiorly and medially. In the past, the medial border of the femoral ring was

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mistaken for the lacunar ligament. The lacunar ligament is an attachment of the inguinal ligament to the pubic bone, however, and lies in the outer layer of the transversalis fascia. McVay demonstrated that the medial boundary of the femoral ring is the lateral edge of the aponeurosis of the insertion of the transversus abdominis muscle with transversalis fascia onto the pectin of the pubis, not the lacunar ligament [3]. Condon also demonstrated that the iliopubic tract bridges the femoral canal and then curves posteriorly and inferiorly, its fibers spreading fanwise to insert adjacent to Cooper's ligament into a broad area of the superior ramus of the pubis [4]. Thus, the true inner ring of the femoral canal is bounded by the iliopubic tract anteriorly and medially, and by Cooper's ligament posteriorly. If a surgeon incises the inguinal ligament in a tightly incarcerated femoral hernia, he or she will find that the hernia cannot be reduced because of the more deeply placed ring [5]. The distal orifice has a rigid boundary—surrounded by the lacunar ligament medially; the inguinal ligament superiorly; and the fascia of the pectineal muscle—and is usually less than 1 cm in diameter. The rigidity of these structures is the reason why strangulation often occurs in femoral hernias. Lytle has described in detail the three-dimensional aspects of the femoral ring, canal and distal orifice [6,7].

Etiology

The etiology of femoral hernia has been controversial. The theory of a congenital preformed peritoneal sac in femoral hernia was advanced by many authors in the early twentieth century [8,9]. Keith completely discredited this theory in 1923, however. He stated that there is never a congenital preformed femoral hernia sac passing through the femoral ring, and that the femoral ring is a kind of safety valve for expansion of the femoral vein in the upright posture. He also emphasized that any weak area in the abdominal wall subjected to a constant repetition of increased intra-abdominal pressure will develop a hernia at that site [10]. Following Keith's paper, several papers were published that stated that the femoral hernia is an acquired disease [1,11,12]. Currently, the "acquired" theory is widely accepted; however, the true cause of femoral hernia is not known. McVay demonstrated that the width of the femoral ring, which is determined by the length of the fanwise insertion of the iliopubic tract to Cooper's ligament, is the main etiologic factor of the femoral hernia [13]. Considering that the femoral hernia is very rare in children and most common in elderly women, however, McVay's concept cannot be the only reason for the occurrence of femoral hernia. Nyhus noted the presence of a relatively large femoral defect without an accompanying femoral hernia during the preperitoneal approach [14]. This may be caused by the acquired weakness of the transversalis fascia and a consequent predisposition to the development of the femoral hernia.

Elevated intra-abdominal pressure caused by constipation, bronchitis, and pregnancy is considered to be the prime etiologic factor, because

femoral hernia is common in multiparous females. Keith demonstrated that the increased incidence in multiparous women resulted from the elevated intra-abdominal pressure that dilated the femoral vein, which in turn stretches the femoral ring [10]. Under the continuous increased intra-abdominal pressure, the preperitoneal fat tissue insinuates itself into the femoral ring and leads to the development of a femoral peritoneal sac. Then, the peritoneal sac moves down to the femoral canal and out the femoral orifice. When it moves out the femoral orifice, it becomes apparent and of clinical consequence because the outer orifice of the femoral canal surrounded by the inguinal ligament, the lacunar ligament, and the pectineal fascia are so rigid that the projection of the femoral hernia sac through the femoral orifice often results in incarceration or strangulation.

Incidence

The ratio of femoral hernia relative to all groin hernias is reported to be 2% to 8% in adults [15,16,17]. Femoral hernias are very rare in children [18], and most commonly observed between the ages of 40 and 70. The peak distribution is in the 50s, with a slight decrease in the 60s and 70s. As for sex distribution, femoral hernia is 4 to 5 times more common in female than in male; however, there are some reports that it is more common in men than in women [19,20]. A right-sided presentation is more common than left, but the reason is not known [2,16,21].

Diagnosis

When I diagnose the femoral hernia, I always visualize a line over the inguinal ligament on the skin and palpate the area below the line. Usually a small irreducible soft mass is palpated. This means that incarceration of the hernia sac is present. The differential diagnosis between hernia sac, lipoma, and lymphadenopathy is extraordinarily difficult because, in the femoral canal, preperitoneal fat tissue and deep inguinal lymph nodes normally exist. A solitary lymph gland at the opening of the femoral canal is often referred to as Cloquet's gland and can be mistaken for a hernia. Making the diagnosis even more difficult is that when the femoral hernia sac is large, it frequently turns upwards and mimics an inguinal hernia.

Strangulation also occurs more frequently in femoral hernia than the inguinal hernia. It causes acute abdominal pain and small bowel obstruction. If abdominal pain is present in an older female patient, then I always palpate the inguinal and femoral region first. Richter's hernia sometimes occurs in femoral hernia and strangulation of the small intestine usually follows [22]. It is difficult to make an early diagnosis of Richter's hernia before the necrosis of the strangulated small intestine begins.

History of femoral hernia repair

There are three approaches to femoral hernia repair, (1) femoral, (2) inguinal, and (3) extraperitoneal.

Femoral approach

In 1879, Socin was the first surgeon who described a femoral approach to femoral hernia repair [23]. He ligated the hernia sac and returned the peritoneal stump to the abdomen. His method led to a high incidence of recurrence. In 1885, Bassini performed the closure of the femoral ring by placing two sutures from the inguinal ligament to the pectineal fascia, picking up the lacunar ligament on the way, and placing five sutures from the falciform process to the pectineal fascia [24]. In 1892, Marcy used a purse-string suture to close the femoral ring [25]. Cushing recommended and performed a similar technique in 1888 [26]. Cushing's recurrence rate was more than 5%, however, and ultimately greater than the recurrence rate with the inguinal approach [27]. This is why the femoral approach was abandoned and replaced by the inguinal approach. In the mid-twentieth century, there were very few individuals who performed this operation for femoral hernia repair. Glassow of Shouldice Hospital was one surgeon who favored this method by using two lines of wire sutures for the closure of the femoral opening, with a 2% recurrence rate [15,28].



Fig. 1. A small skin incision (approximately 3 cm) is made beneath the inguinal ligament. (Figs. 1–11 are drawn by Mr. Leon Sakuma.)

The surgeon who repopularized the femoral approach was Irving Lichtenstein. He introduced the idea of a “tension-free” femoral hernioplasty in 1974. He rolled a piece of polypropylene mesh into a cylindrical shape, termed it a plug, and inserted it into the femoral canal from the femoral side [29]. In 1992 Shulman et al presented an additional report about the efficacy and low recurrence rate of this technique [30]. Arthur Gilbert further evolved the idea of mesh plugs in the late 1980s. He designed a mesh plug that was rolled by hand into the shape of a cone or umbrella. He believed this configuration worked better than Lichtenstein’s cylinder-shape plug [31]. At the same time, Rutkow and Robbins designed a preshaped mesh plug, called PerFix (Bard, Murray Hill, NJ), that could be used to repair both inguinal and femoral hernias [32].

Inguinal approach

In 1804, Astley Cooper described the anatomy of the transversalis fascia and the superior pubic ligament, which later came to bear his name [33]. He never used Cooper’s ligament for hernia repairs, however. The first surgeon who tried the inguinal approach to the femoral hernia repair was Annandale in 1876 [34]. He only sutured the hernia sac, and did not repair the posterior wall by the Cooper’s ligament or the inguinal ligament. The first surgeon

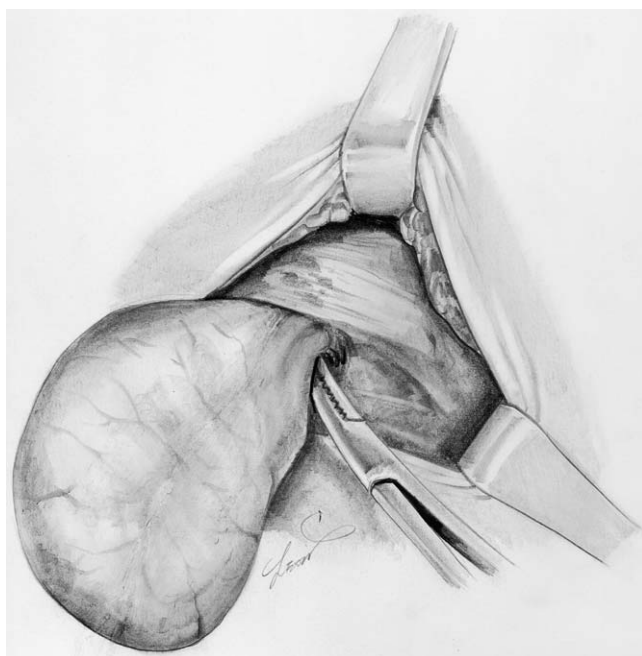


Fig. 2. The hernia sac is dissected gently with complete hemostasis to the femoral orifice.

who used the Cooper's ligament for any hernia repair was Ruggi in Bologna in 1892 [35]. He sutured the inguinal ligament to the Cooper's ligament for the femoral hernia repair. This method was modified by Moschowitz, who added an inguinal hernioplasty to reduce the inguinal recurrence rate, and the repair became quite popular in North America [36]. In 1898, George Lotheissen first sutured the conjoined tendon to the Cooper's ligament in a recurrent hernia case [37]. He noticed that his method covered the femoral ring and then proceeded to use his method to perform femoral hernioplasty. In 1942, Chester McVay demonstrated that the transversus abdominis muscle and the transversalis fascia inserts into Cooper's ligament, not into the inguinal ligament [38], and recommended the Cooper's ligament repair with a relaxing incision as a method to treat femoral hernias [39]. McVay's work provided a basic anatomical understanding to the problem of femoral hernia [40], and the Cooper's ligament repair was adopted by surgeons throughout the world [7,21,41,42].

Extraperitoneal approach

In 1921, Cheatle first performed the extraperitoneal approach [43], and Henry also performed the same approach via a suprapubic incision, in which the rectus abdominis muscle was separated in the midline [44]. The superior and inferior boundaries made by the transversalis fascia were

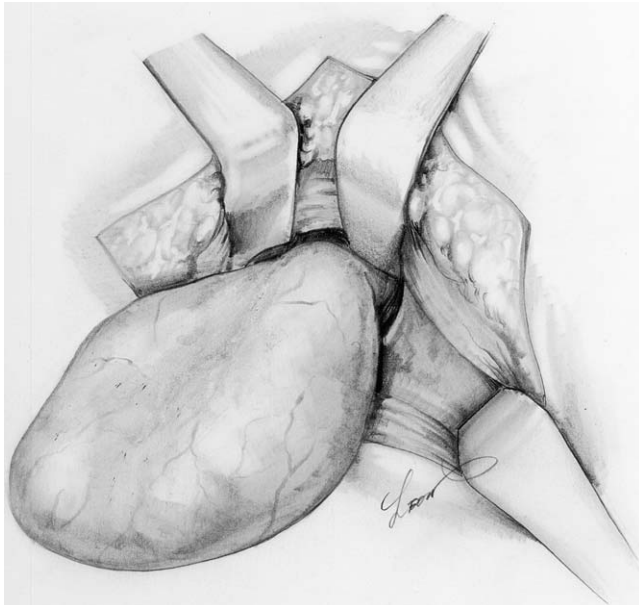


Fig. 3. Two muscle retractors are inserted between the transversalis fascia and the hernia sac to enlarge the defect.



Fig. 4. The contents of the hernia sac are usually reduced with fingers.

approximated by sutures. In 1960, Lloyd Nyhus used a transverse incision placed two finger breadths cephalad to the superior border of the pubis, and exposed the femoral ring by a preperitoneal approach [45]. He reduced and excised the femoral hernia sac, and approximated the iliopubic tract to Cooper's ligament. The recurrence rate was 1% [46]. Nyhus also recommended this procedure for incarcerated or strangulated femoral hernias, in which the resection of a necrotic segment of bowel is necessary. In 1973, Stoppa began placing a large bilateral piece of polyester mesh by a midline preperitoneal approach [47]. The recurrence rate of his method was reported to be 3%. In 1990, Edward Phillips used Stoppa's extraperitoneal hernia repair, but by laparoscopy [48]. Phillips' laparoscopic technique of hernia repair by the extraperitoneal approach, using blunt and balloon dissection, is called total extraperitoneal repair (TEP).

My operative strategy for femoral hernia

In Yokkaichi Municipal Hospital, mesh plug repair was introduced in 1995 for all groin hernias [49]. Since then, mesh plug repair has become the

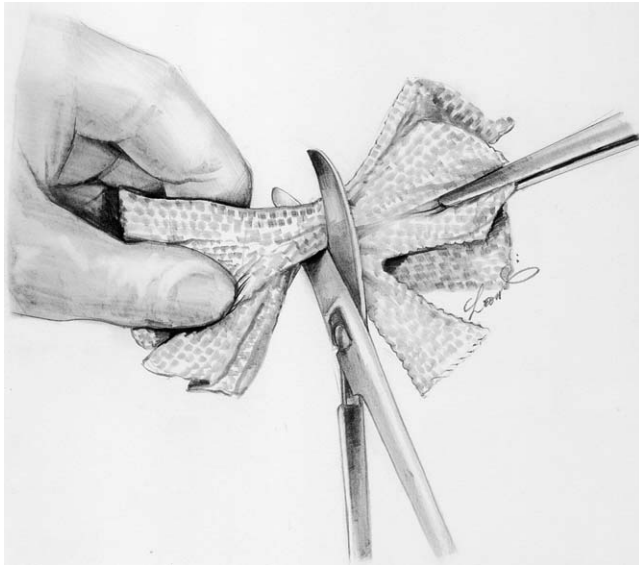


Fig. 5. All inside petals of PerFix plug are removed with scissors to fit the size of the defect.

first choice for femoral hernia, except for cases in which strangulation resulted in necrosis of small intestine, omentum or other organs. In these cases, Cooper's ligament repair was used, but without placement of a mesh prosthesis. Recently, however, even when the intestine is necrotic and requires resection, a mesh plug has been used if peritonitis or an abscess is not apparent.

Surgical technique

Mesh plug repair

The repair is performed under local anesthesia by 1% xylocaine. A small skin incision (approximately 3 cm) is made beneath the inguinal ligament (Fig. 1). Subcutaneous tissues are dissected with electrocautery. The hernia sac is completely dissected, again using electrocautery, to the level of the femoral orifice (Fig. 2). The hernia defect is usually less than 2 cm, so reduction of the hernia sac is sometimes difficult. In such a case, I often insert two muscle retractors between the transversalis fascia and the hernia sac, under the inguinal ligament, thereby slightly enlarging the defect to aid in manual reduction (Fig. 3). When the color of the hernia contents is judged satisfactory, then contents are reduced with fingers (Fig. 4). If the surgeon suspects strangulation, then the sac should be opened and visually checked. After reduction of the hernia sac, an appropriate size PerFix plug is selected. In most cases, a medium-sized PerFix plug is used and all eight of the inside mesh petals are removed (Fig. 5). This way, the bulk of mesh that is to be

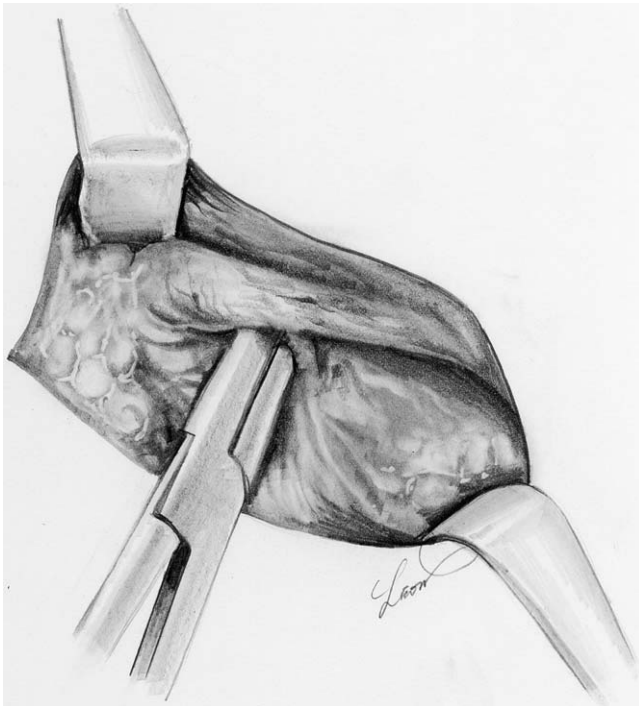
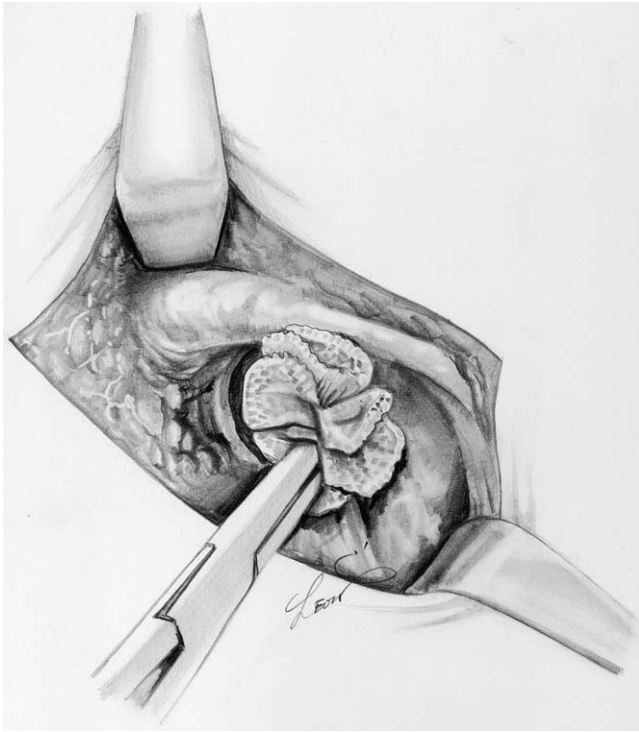


Fig. 6. The plug is inserted into the femoral canal through the femoral orifice.

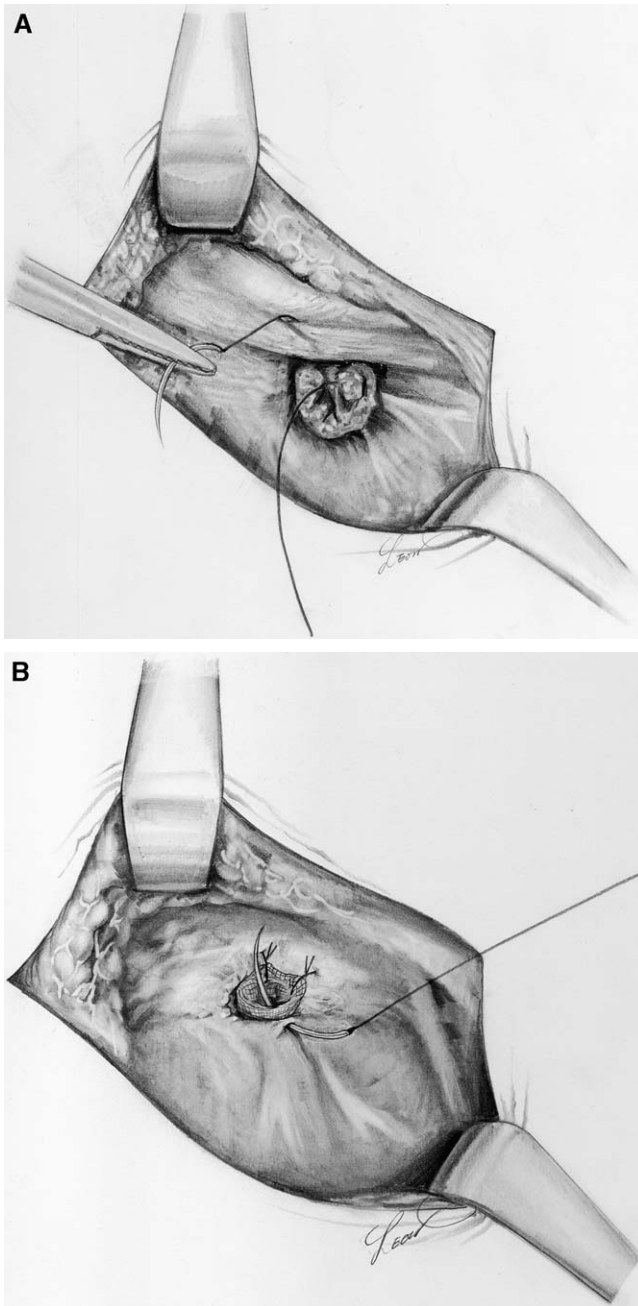


Fig. 7. The plug is fixed with absorbable interrupted sutures (4-0 Vicryl) to the inguinal ligament (A), the lacunar ligament and the pectineal fascia (B).

placed within the femoral canal is reduced, causing less interference to neighboring structures. Then, the plug is inserted into the femoral canal through the femoral orifice (Fig. 6A, B) and fixed with absorbable interrupted sutures (4-0 Vicryl [Ethicon, Somerville, NJ]) to the inguinal ligament, the lacunar ligament, and the pectineal fascia (Fig. 7A, B). No suture should be placed laterally, to avoid injuring the iliofemoral vessels. The number of sutures used for plug fixation should be kept to a minimum to reduce the possibility of injuring a peripheral nerve. Unlike an inguinal hernia PerFix plug repair, for femoral hernias an onlay patch is not required. The patient is asked to cough to ensure proper positioning and fixation of the plug. One or two absorbable sutures are employed to approximate the subcutaneous tissue. Skin closure is accomplished by absorbable sutures.

Cooper's ligament repair

Skin incision is made above the inguinal ligament. Subcutaneous tissue and Scarpa's fascia are dissected with electrocautery to the level of the external oblique aponeurosis. Before opening the aponeurosis, the thigh fascia below the inguinal ligament is incised to displace the fat tissue surrounding the femoral hernia sac and permit dissection of the sac to the level of inguinal ligament. When strangulation is suspected, the hernia sac should be opened below the inguinal ligament and the contents checked.

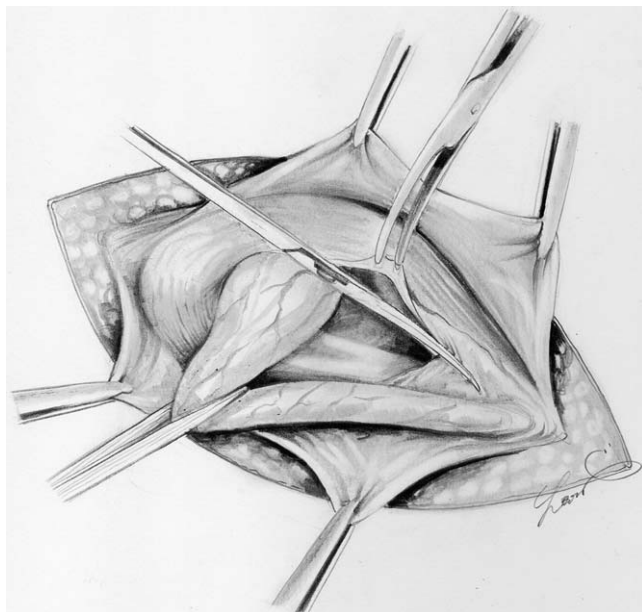


Fig. 8. The posterior wall of the inguinal canal is sharply incised.

If the contents are judged necrotic, I proceed with a Cooper's ligament repair.

The external oblique aponeurosis is split from the external ring to the internal ring, and an attempt is made to identify and preserve the ilioinguinal nerve. The internal oblique muscle is retracted upward, and the inguinal ligament and the iliopubic tract are exposed. The spermatic cord is freed and encircled by a thin rubber tape. The transversalis fascia of the posterior wall of the inguinal canal is sharply opened (Fig. 8). Usually, the hernia sac is found medial to the inferior epigastric vessels with a large amount of surrounding fat tissue. The hernia sac is gently dissected and encircled by a rubber tape (Fig. 9). Then, the dissection to free the hernia sac from the inguinal ligament is performed in the femoral canal. When the sac is empty, it is easily reduced. In most cases, however, the reduction is so difficult that the femoral ring is dilated with muscle retractors to pull up the hernia sac. Then, the hernia sac is opened to inspect the hernia contents. If they are considered necrotic, then they are resected, and if needed, gastrointestinal anastomosis is performed. In some cases, the necrosis is

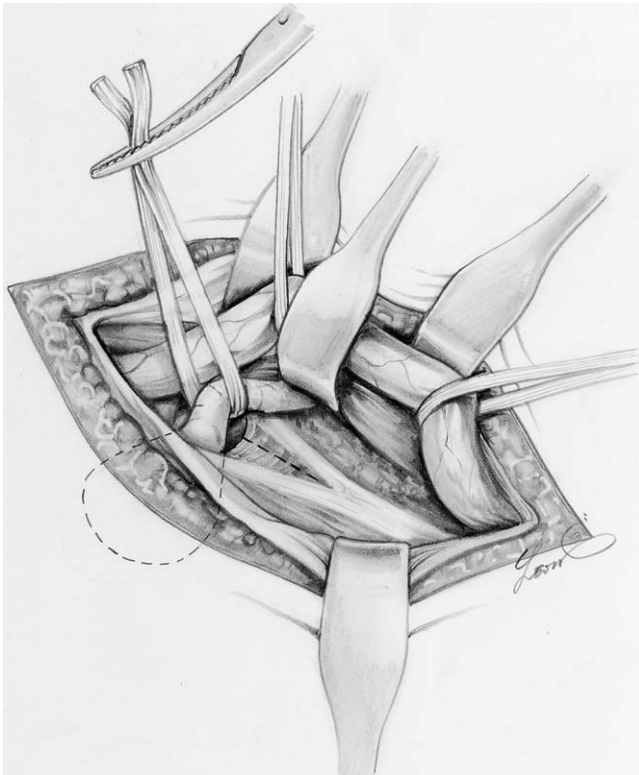


Fig. 9. The hernia sac is dissected gently and encircled by a rubber tape.

so severe that a large amount of purulent ascites exists in the abdomen. Intra-abdominal lavage with saline should be performed in those cases. After the procedures, the hernia sac is ligated at the level of the peritoneum with absorbable sutures (Fig. 10). The reinforcement of the posterior wall of the inguinal canal is now performed. Medially, the sutures are placed, beginning at the pubic tubercle, through the transversus abdominis arch above and the Cooper's ligament below. At the medial edge of the femoral ring, the sutures are placed through the transversus abdominis arch, Cooper's ligament, and the iliopubic tract (Fig. 11). The lateral sutures are called "transition sutures" and will close the femoral canal. The sutures are tied from medial to lateral after their placement.

Results

From 1995 through 2002, a total of 67 femoral hernia repairs in 63 patients were completed. There were 4 patients with bilateral femoral hernias. Fifty-six patients were female, whereas only 7 were male. In females during these years, the percentage of femoral hernias among all groin

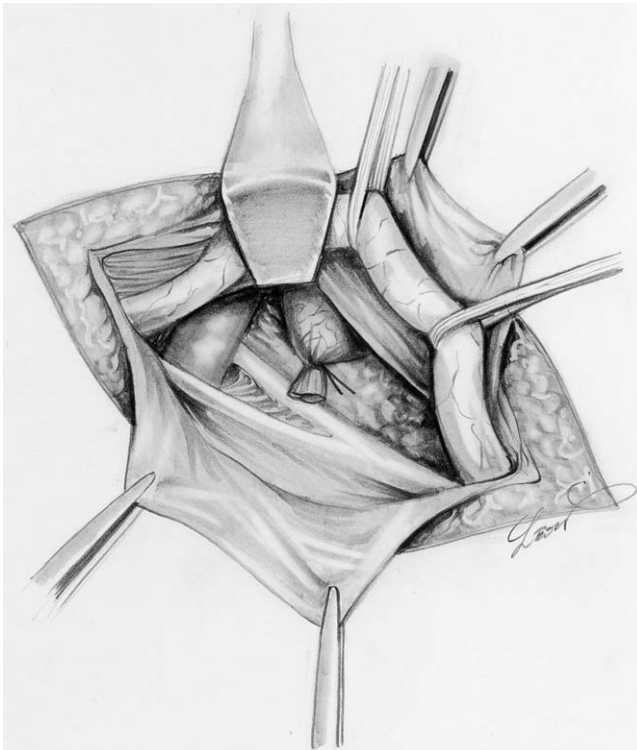


Fig. 10. The hernia sac is ligated at the level of the peritoneum with absorbable sutures.

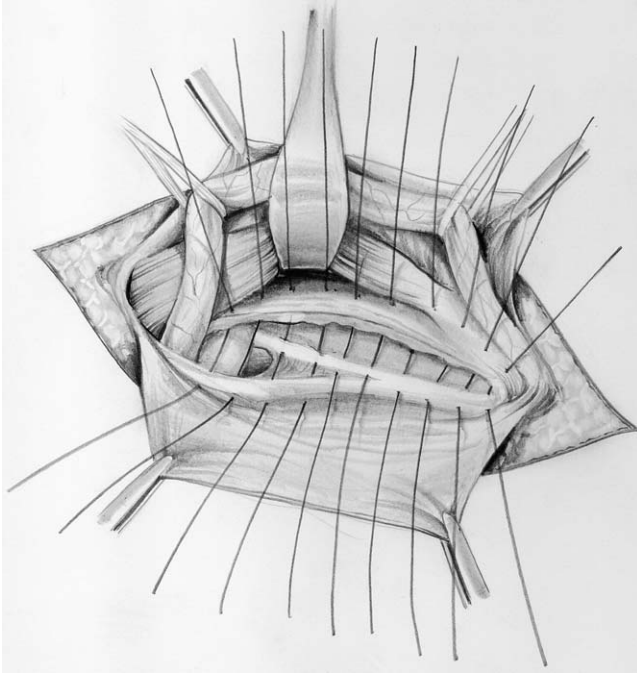


Fig. 11. The reinforcement of the posterior wall and the closure of the femoral ring are simultaneously performed. At the femoral ring, the sutures are placed through the transversus abdominis arch, Cooper's ligament, and the iliopubic tract.

hernias was 30%, in contrast to less than 1% in men. Right (46 cases, 70%) was more common than left (20 cases, 30%). The patients ranged in age from 30 to 80, and the average age was 64 (Fig. 12). In 17 patients (30%), the femoral hernia was repaired as an emergency operation. In elective cases, all operations were repaired by the mesh plug technique. The average operating time was 27 minutes. There were no major complications and only one recurrence, which occurred on the same side 2 months after the femoral hernia repair and probably represented a missed inguinal hernia.

In emergency cases, incarceration was found in 14 cases (82%). The incarcerated tissues included 10 small intestines and four omentums. Six of the 10 incarcerated small intestines and three of the four incarcerated omentums were strangulated and needed to be resected. In strangulated cases, Cooper's ligament repair was usually performed. Over the past two years, however, I have begun to use the PerFix mesh plug even in cases in which the small bowel or omentum is strangulated, as long as neither severe peritonitis nor abscess is found. I have had two cases of small-bowel strangulation and two cases of omentum strangulation in which the plug repair was used, and there were no untoward complications or mesh infections.

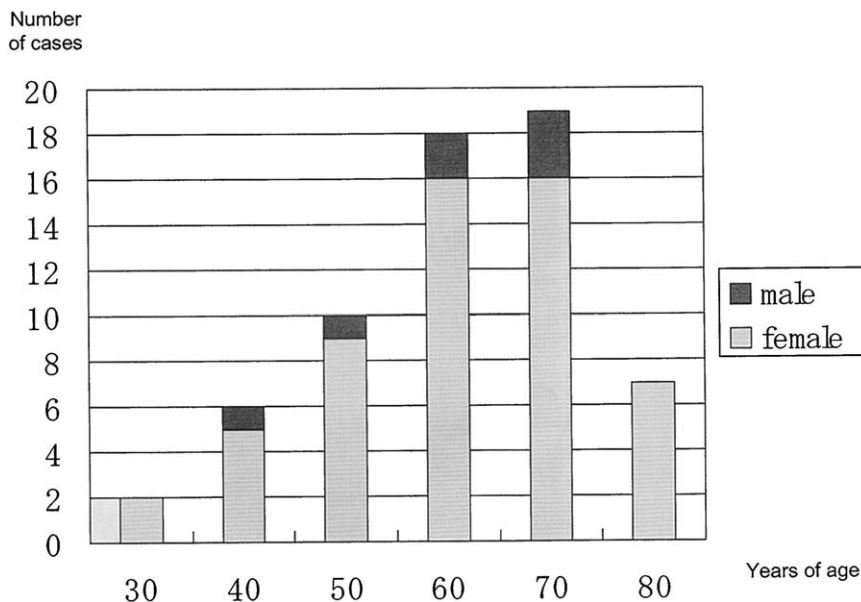


Fig. 12. Age and sex distribution of femoral hernia in Yokkaichi Municipal Hospital for 7 years.

Summary

Femoral hernia repair has a long history. In the nineteenth century, simple closure of the femoral orifice by the femoral approach was favored. Such renowned surgeons as Bassini, Marcy, and Cushing authored papers about the femoral approach to femoral hernia. The recurrence rate was so high, however, that it was replaced by the inguinal approach.

The man who popularized the inguinal approach was Chester McVay, who demonstrated the precise insertion of the transversus abdominis muscle and transversalis fascia to the Cooper's ligament. He used Cooper's ligament for the femoral hernia repair by the inguinal approach. The complication and recurrence rate after the Cooper's ligament repair for femoral hernia was not satisfactory, however, due to tension on the approximated tissues, which caused postoperative pain and inability to resume normal activities. Irving Lichtenstein first introduced the plug technique to femoral hernia repair and it was further developed by Gilbert and Rutkow. In the present series, all elective cases were repaired by the PerFix mesh plug technique without any complications. Patients were discharged from the hospital on the first postoperative day and returned to normal activities shortly thereafter. These patients had few complaints of pain in the groin. The operating time using a PerFix plug was markedly

shorter when contrasted with the Cooper's ligament repair. No infection of the prosthesis occurred, even in the cases in which the small intestine was necrotic and resected. From our 7-year experience of mesh plug femoral hernia repairs, I have come to regard this operation as the first choice in elective and noninfected cases of femoral hernia. In strangulated cases in which severe infection occurs, Cooper's ligament repair should be used, because there is a risk of infection to implanted prosthesis.

Finally, femoral hernia is usually thought of as requiring emergency surgical treatment [50]. Only 30% of our cases were treated as emergency operations, however, whereas 70% were elective. Unless patients complain of severe abdominal pain or ileus, surgeons need not perform emergency operations. In summary, the PerFix mesh plug hernia repair for femoral hernia has resulted in a reduced recurrence rate, shortened hospital stay, and a low rate of postoperative complications.

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