Since the first true herniorrhaphy was performed by Bassini over 100 years ago, all modifications and surgical techniques have shared a common disadvantage: suture line tension. The anatomic, physiological, and pathologic characteristics of hernia recurrence are examined. The prime etiologic factor behind most herniorrhaphy failures is the suturing together, under tension, of structures that are not normally in apposition. With the use of modern mesh prosthetics, it is now possible to repair all hernias without distortion of the normal anatomy and with no suture line tension. The technique is simple, rapid, less painful, and effective, allowing prompt resumption of unrestricted physical activity.

The main reason for the repair of inguinal hernia remaining a problem is the wide discrepancy between the monotonous excellence achieved in personal series and the uniformly depressing results obtained by impersonal statistical reviews . . . yet impersonal reviews indicate that the recurrence rate remains excessively high and fairly constant, whatever method and material is employed [1].

Each year in the United States, there are over a half million groin hernia repairs [2]. Of these, between 50,000 and 100,000 are for recurrent inguinal hernia. A study in 1983 by the Rand Corporation [3] also concluded that at least 10 percent of all primary hernia repairs will fail.

Reports by individual persons or institutions have generally been flawed for the following reasons: (1) Different surgical methods and differences in individual techniques with the same method. (2) Inadequate length of follow-up. A review of the literature revealed that 50 percent of recurrences first appear 5 or more years after the original operation [4]. Ravitch [5] pointed out that 20 percent of recurrences are first discovered 15 to 25 years postoperatively. Statistical significance demands at least a 5-year, and preferably a 10-year, follow-up. This requires dedication on the part of the surgeon, since physician examination is a primary requirement in determining the presence or absence of a recurrence. In addition, it is the only method by which the many claims and counterclaims can be accurately evaluated in the search for a consistently effective operation. (3) Significant numbers of patients are lost to follow-up. This is the group in which the highest number of recurrences are likely to be present [6]. Impressions or assumptions based on the failure of a patient to return are completely misleading. Scattering patients lost to follow-up uniformly through the various groups of reported cases results in statistical distortion. It is erroneous to assume that the recurrence rate is the same in nonexamined and examined cases, since the dissatisfied patient will seek medical service elsewhere and therefore is less likely to return for follow-up examination. Lack of adequate long-term critical follow-up is the prime cause behind the remarkable variation in reported results from sophisticated investigations. Written questionnaires are notoriously unreliable (up to 50 percent of patients with hernias are unaware of their condition) [7].

PATHOPHYSIOLOGIC CHARACTERISTICS
It is appropriate to accurately define terms. Fascia is connective tissue, a very flimsy lining usually of one cell thickness, with more or less condensation into a definite layer [8]. Such tissue envelops all muscular and aponeurotic layers but lacks the organization and strength of an aponeurosis. The aponeurotic layers in the groin are the tendinous insertions of the three flat abdominal wall muscles: the external oblique, internal oblique, and transversus abdominis. Since tendons are composed of very strong collagenous tissues, they should be employed exclusively rather than fascia for herniorrhaphy. This distinction is vital because the transversalis fascia has little strength and is of questionable value as a supporting layer for herniorrhaphy. As stated by Condon [8]:

This is an important point to keep in mind when reviewing the surgical literature, as in recent years particularly, a great deal of emphasis has been placed on transversalis fascia and its role in hernial repair. Transversalis fascia is of varying density and is often quite thin, even transparent. It possesses little intrinsic strength and, by itself, is a worthless material as far as the construction of a sound hernia repair is concerned.

The human inguinal canal is protected by two guards: an outer and an inner. The outer guard is the external oblique aponeurosis; the inner, more complex, guard was first described by Cooper in 1807 [9]. It consists inferiorly of Poupart's ligament, a structure peculiar to man, and Cooper's ligament. The superior part of the inner guard is represented by the combined internal oblique and transversus muscles, which arise from the lateral portion of Poupart's ligament. They arch above the spermatic cord at the internal ring; they end at the rectus aponeurosis. When these muscles are relaxed, there is an interval between their lower border and Poupart's ligament, which is filled by the thinned and often diaphanous transversalis
When these muscles contract, their lower edges approximate with Poupart's ligament like a shutter or curtain, thus diminishing the inguinal gap. Since the transversalis fascia is the only cover bridging the gap, it is the key area or the "Achilles heel" of the groin. It is the only portion of the abdominal wall not protected by a musculoaponeurotic layer. The very presence of a hernia is proof that this fascia is inadequate. This architectural error was exposed when man, in his determination to walk upright in order to feed himself, to fight, or for flight, created an unsupported area.

It is the genetic predisposition, few or no collagen fibers from the transversus abdominis aponeurosis extending into the transversalis fascia layer, decreased collagen turnover, or increased collagen degradation that predisposes to deterioration of the transversalis fascia and the development of inguinal hernia.

Recurrences are almost invariably located in juxtaposition to the pubic tubercle or the internal ring. Why? The deep inguinal ring is formed basically by aponeurotic or muscular fibers of the transversus abdominis layer. The inferior border of the ring is usually entirely aponeurotic, being formed by the iliopubic tract and the inguinal ligament. The transversus abdominis arch, having crossed over the spermatic cord at the deep ring, then curves gently downward across the groin. In a study of 135 cadaver dissections, Condon noted that in almost 70 percent of cases, this arching line was between 0.5 and 2 cm above the superior ramus of the pubis (Figure 1, right). In 15 percent of the cases, it was very high in the groin, more than 2 cm above the pubic bone. Only 11 percent of the dissections revealed the transversus abdominis aponeurosis inserting into the superior pubic ramus. Therefore, there are two basic reasons why recurrences are located at the internal ring or at the pubic tubercle: (1) It is evident that with conventional hernia repair, reinforcement of the canal floor at the pubic tubercle demands suturing together of tendinous structures that are normally not in apposition. At the internal ring, approximation of the transversus abdominis fibers is prevented by the emergence of the spermatic cord (Figures 2 and 3). Suture line tension is the inescapable result. This is a clear violation of basic surgical principles and is the ultimate cause of recurrence. (2) The sutures at the most medial and lateral ends of the repair have no bordering stitches to distribute the distractive force more uniformly. The center of the repair is strongest. This predisposes to tearing at either end of the suture line and can begin an unzippering effect with time.

In 1884, Bassini performed the first true herniorrhaphy; 5 years later, he reported an incidence of recurrence of 10 percent. There has been little improvement in results during the past 100 years. Since Bassini performed his herniorrhaphy over a century ago, all repairs, including Halsted, Shouldice, and McVay repairs, regardless of the modifications, have shared one common disadvantage: tension on the suture line. It is the conviction of the surgeons at our institution that this tension is the cause of eventual suture or tissue disruption and the prime etiologic factor in hernia recurrence. A technique is described that eschews all suture line tension, the "bête noir of all hernia surgeons." Modern mesh prosthetics have been widely used in surgery for the past 30 years. Polypropylene (Marlex) is strong, monofilamented, inert, and readily available; it is unable to harbor infection, is very thin and porous, its interstices become completely infiltrated with fibroblasts and remain strong permanently, it is not subject to deterioration or rejection, and it cannot be felt by patient or surgeon postoperatively.

Other mesh screens, such as Gore-Tex, Mersilene, Tantalum, share various disadvantages. Gore-Tex has...
Figure 2. The transversus abdominis tendon is ordinarily approximated to the inguinal ligament in the standard repair. A, rectus sheath; B, internal oblique muscle; C, transversus aponeurosis.

Figure 3. Diagrammatic sagittal view of the stretched transversus aponeurosis sutured to the inguinal ligament. A, external oblique aponeurosis; B, internal oblique muscle; C, transversus aponeurosis; D, transversalis fascia; E, peritoneum.

an infinite number of pore sizes and presents innumerable crevices in which bacteria can hide and proliferate. Furthermore, it is never sufficiently infiltrated by a fibrous tissue response. Mersilene, on the other hand, has braided fibers and does not stimulate a marked fibroblastic infiltration. Tantalum is subject to fatigability, becomes fragmented, and pain from pricking ends can be annoying.

Our experience with Marlex over 25 years and many thousands of cases reveal it to be a safe and ideal substance for permanent reinforcement of hernial defects [5]. With the use of this polypropylene mesh, it is now possible to eliminate formal reconstruction of the canal floor with its concomitant anatomic distortion. Also, suture line tension is completely avoided. The technique is simple, rapid, less painful, and effective for primary hernia repair. It has reduced the failure
rate at our institution to 0 (admittedly, with less than 6 years of follow-up) and permitted prompt resumption of unrestricted physical activity postoperatively.

**TECHNIQUE**

Under a local anesthetic block, the inguinal canal is opened and the hernia identified. If there is an indirect sac, it is opened in order to explore the canal floor and simply inverted into the abdomen without excision, su-

![Image](image-url)

Figure 4. Left: Direct hernia. A, hemial sac; B, external oblique aponeurosis; C, internal oblique aponeurosis; D, rectus sheath; E, transversus fascia; F, spermatic cord; G, ilioinguinal nerve. Right: Sagittal view of direct hernia. A, external oblique aponeurosis; B, internal oblique muscle; C, transversus aponeurosis; D, transversus fascia; E, peritoneum.

![Image](image-url)

Figure 5. Inverted hernial sac. A, internal oblique muscle; B, external oblique aponeurosis; C, spermatic cord; D, epigastric vessels; E, inverted sac; F, rectus sheath.

ture, or ligature [14]. If direct sacs are large, they may be inverted by means of a single absorbable invaginating suture (Figures 4 and 5). A sheet of prosthetic mesh measuring about 5 by 10 cm is fashioned. The lower edge is tacked in place by a continuous suture of 0-0-0 Nova-

![Image](image-url)

Figure 6. Inverted sac. A, internal oblique muscle; B, external oblique aponeurosis; C, spermatic cord; D, epigastric vessels; E, inverted sac; F, rectus sheath.
The cremaster envelope which encases the spermatic cord is incised into two bundles. A, internal oblique muscle; B, external oblique aponeurosis; C, spermatic cord and ilioinguinal nerve; D, inferior cremaster bundle; E, genital nerve; F, superior cremaster bundle; G, genital branch of genitofemoral nerve proceeding to exit of the external ring. When thinning the cord, if the genitofemoral nerve cannot be clearly identified, the inferior cremaster muscle bundle containing the nerve and the external spermatic vessels may exit through a separate opening medial to the internal ring (Figures 6 and 7, left). The superior edge of the mesh is loosely secured by a similar continuous suture to the rectus sheath and conjoined muscle and tendon above. A single suture approximates the tails of the mesh to Poupart's ligament lateral to the internal ring. This alone completes the repair without formal reconstruction of the canal floor. The usual approximation of aponeuritic tissue under tension is avoided.

Since the patient is awake and able to cooperate, he is requested to cough and perform the Valsalva maneuver in order to test the strength of the repair. The external oblique aponeurosis is closed over the cord with a continuous absorbable suture (Figure 7, right).

RESULTS
This technique was employed in the last 1,000 consecutive patients with primary repair followed from 1 to 5+ years. There were no recurrences. This must be considered a preliminary report in view of the short follow-up period; however, the results to date have been extremely satisfying.

No infection was encountered (the screen and nonabsorbable sutures were monofilamented). In addition, a powder containing polymyxin and bacitracin was sprinkled into all wounds. Since these drugs are never used systemically, acquired sensitivity is not a concern. There were two hematomas that resolved spontaneously. Patients suffered less discomfort and were encouraged to return to full unrestricted activity as soon as possible, frequently resuming manual labor within 2 to 3 days postoperatively.

COMMENTS
The prime cause of recurrent inguinal hernia is the approximation of normally unapposed tissues. This creates tension, a clear violation of basic surgical principles. This new concept permits hernia repair without distortion of the normal anatomy and without any suture line tension; the use of local anesthesia, thus allowing intraoperative testing; repair in an ambulatory (same-day) environment; prompt return to unrestricted activity; and a
recurrence rate approximating 0. Finally, the technique is simple, rapid, relatively less painful, safe, and effective.

REFERENCES