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# Long-term result and current status of the Lichtenstein open tension-free hernioplasty

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**Summary:** The tension-free hernioplasty project began in 1984 at the Lichtenstein Hernia Institute. The method consists of complete reinforcement of the inguinal floor with a large sheet of mesh, with adequate mesh tissue interface beyond the boundary of the inguinal floor and creation of a new internal ring made of prosthesis. The preliminary report of this operation was published in 1989, with no recurrence at that point in time. Shortly after the submission of the report, several recurrences were encountered. Based on the lesson learned from those recurrences, the operation was slightly modified and reported in 1991 [Amid 1993]. Since then, the Lichtenstein technique has gained world-wide popularity. Outcome measures identical to ours and other authors have been achieved by even those surgeons who have no special interest or expertise in herniology. The purpose of this article is to report the current state of the open tension-free hernioplasty for the repair of primary and recurrent inguinal hernias.

**Key words:** Tension-free hernioplasty – Mesh repair – Mesh plug – Recurrent inguinal hernia.

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For more than a century, the measure of the success of hernia repair was its recurrence rate. In 1966, for the first time, the importance of the postoperative disability period of hernia repair was brought to the attention of surgeons by Lichtenstein [1966]. With the goals of decreasing postoperative pain, recovery period, and recurrence rate, the tension-free hernioplasty project was started at the Lichtenstein Hernia Institute in June of 1984. The concept is based on: a) the degenerative origin of inguinal hernia which results in destruction of the inguinal floor [Read 1992]; b) the fact that the traditional tissue repair is associated with undue tension at the suture line.

The procedure is performed under local anesthesia, which is our preferred choice for all reducible adult inguinal hernias [Amid 1994]. It is safe, simple, effective, economical, and without any side effects or the risk of urinary retention. Furthermore, local anesthesia administered prior to making the incision produces a prolonged analgesic effect via inhibition of the build-up of local nociceptive molecules [Wall 1988, Woolf 1989]. Several safe and effective anesthetic agents are currently available. Our choice, however, is a 50:50 mixture of 1% lidocaine (Xylocaine) and 0.5% bupivacaine (Marcaine), with 1/200,000 factory added epinephrine.

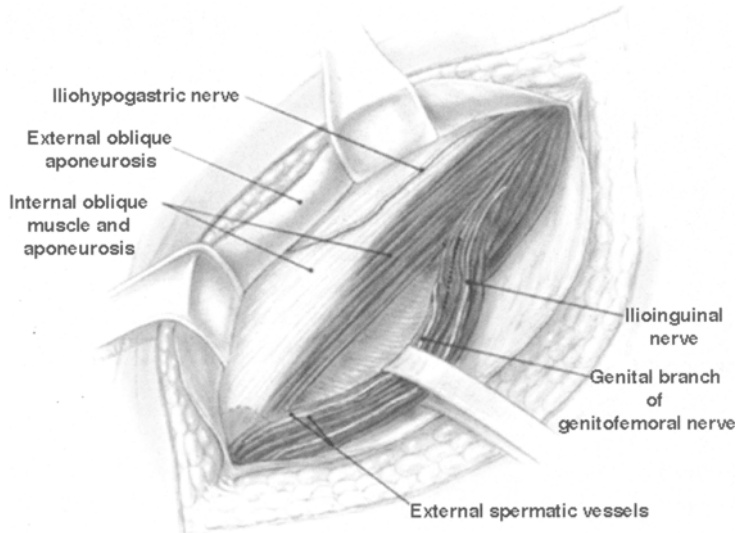


**Fig. 1**
Spermatic cord together with its cremasteric covering, inguinal nerve, external spermatic vessels, and genital nerve is raised and the cremasteric fibers are cut transversely or longitudinally at the level of the internal ring

## Technique of anesthesia

An average of 45 ml of this mixture is usually sufficient for a unilateral hernia repair and is administered in the following fashion.

*Subdermal infiltration*

About 5 ml of the mixture is infiltrated along the line of the incision with a 2-inch long 25 gauge needle inserted into the subdermal tissue parallel with the surface of the skin. Infiltration continues as the needle is advanced. Movement of the needle reduces the likelihood of intravascular infusion of the drugs because even if the needle penetrates a blood vessel, the tip will not remain in the vessel long enough to deliver a substantial amount of the anaesthetic agent intravenously. This step blocks the subdermal nerve endings and reduces the discomfort of the intradermal infiltration which is the most uncomfortable stage of local anesthesia.

*Intradermal injection (making of the skin wheal)*

The needle in the subdermal plane is withdrawn slowly until the tip of the needle reaches the intradermic level. Without extracting the needle completely, the dermis is infiltrated by slow injection of about 3 ml of the mixture along the line of the incision.

*Deep subcutaneous injection*

A total of 10 ml of the mixture is injected deep into the subcutaneous adipose tissue through vertical insertions of the needle (perpendicular to the skin surface) 2 cm apart. Again, injections are continued as the needle is kept moving to reduce the risk of intravascular infusion.

*Subaponeurotic injection*

About 10 ml of the anaesthetic mixture is injected immediately underneath the aponeurosis of the external oblique muscle through a window created in the subcutaneous fat at the lateral corner of the incision. This injection floods the enclosed inguinal canal and anesthetizes all three major nerves in the region while the remaining subcutaneous fat is incised.

It also separates the external oblique aponeurosis from the underlying ilioinguinal nerve, reducing the likelihood of injuring the nerve when the external oblique aponeurosis is incised.

Occasionally it is necessary to infiltrate a few ml of the mixture at the level of the pubic tubercle, around the neck and inside the indirect hernia sac, to achieve complete local anesthesia.

The local anesthesia can be further prolonged by splashing 10 ml of the mixture into the inguinal canal before closure of the external oblique aponeurosis and in the subcutaneous space before skin closure.

Epidural anesthesia is preferred for repair of non-reducible or bilateral inguinal hernias in obese patients. Sedative drugs given by the surgeon, or preferably by an anesthetist as "conscious sedation" via infusion of rapid short-acting, amnesic and anxiolytic agents such as propofol, reduce the patient 's anxiety. This also reduces the amount of local anaesthetic agents required particularly for bilateral inguinal hernia repair.

## Technique of the operation

A 5-cm skin incision, which starts from the pubic tubercle and extends laterally within the Langer 's line, gives an excellent exposure of the pubic tubercle and the internal ring. After skin incision, the external oblique aponeurosis is opened and its lower leaf freed from the spermatic cord. The upper leaf of the external oblique is then freed from the underlying internal oblique muscle and aponeurosis for a distance of 3 cm above the inguinal floor.

The anatomical cleavage between these two layers is avascular and the dissection can be done rapidly and non-traumatically. High separation of these layers has a dual benefit, as it visualizes the iliohypogastric nerve and creates ample space for insertion of a sufficiently wide sheet of mesh that can overlap the internal oblique by at least 3 cm above the upper margin of the inguinal floor. The cord with its cremaster covering is separated from the floor of the inguinal canal and the pubic bone for a distance of about 2 cm beyond the pubic tubercle.

The anatomic plane between the cremasteric sheath and the aponeurotic tissue attached to the pubic bone is avascular, so, there is no risk of dama-

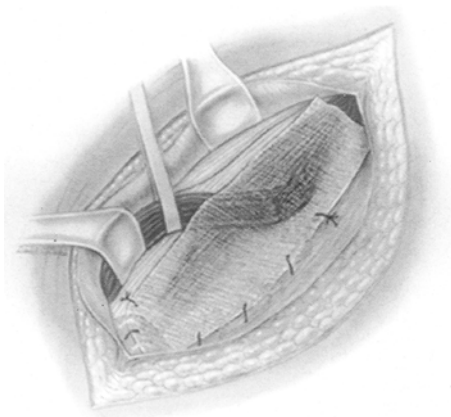

**Fig. 2**
Medial corner of the patch overlaps the pubic bone by 1-1.5 cm

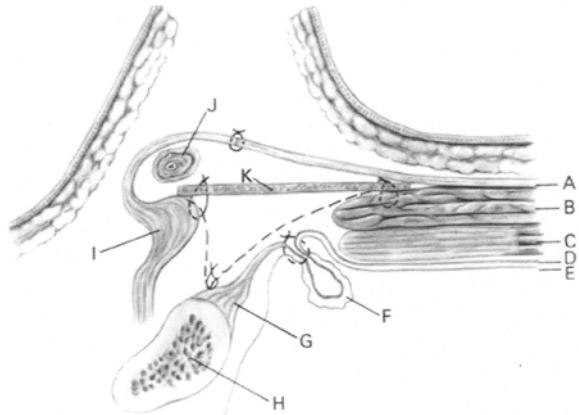


**Fig. 3**
*A*, External oblique aponeurosis; *B*, internal oblique muscle; *C*, transversus aponeurosis; *D*, transversalis fascia; *E*, peritoneum; *F*, inverted direct sac; *G*, Cooper's ligament; *H*, pubis; *I*, inguinal ligament; *J*, spermatic cord; *K*, mesh patch bridging defect. Fixation of the mesh to the ligament of Cooper for closure of the femoral ring (*dotted line*)

ging the testicular blood flow. When lifting the cord, care should be taken to include the ilioinguinal nerve, external spermatic vessels and the genital nerve with the cord. This assures that the genital nerve, which is always in juxtaposition to the external spermatic vessels, is preserved (Fig. 1). Cutting or ligating the genital nerve can cause long term incapacitating neuralgia [Lichtenstein 1988, Salama 1983, Chevrel 1983, 1992, Gatt 1991]. The iliohypogastric nerves should also be preserved.

To explore the internal ring, for indirect hernia sacs, the cremasteric sheath is incised transversely (if thick) or longitudinally at the level of the deep ring (Fig. 1). The latter prevents disturbance of the retractability of the testes. Complete stripping and excision of the cremasteric fibers is unnecessary, and can result in injury to the nerves, small blood vessels, and vas deferens.

Indirect hernial sacs are freed from the cord to a point beyond the neck of the sac and inverted into the abdomen without ligation. Due to mechanical pressure and ischemic changes, ligation of the highly enervated peritoneal sac is a major cause of postoperative pain [Amid 1995]. It has been shown that non-ligation of the indirect hernia sac does not increase the chance of recurrence [Smedgerg 1984]. To minimize the risk of postoperative ischemic orchitis, complete non-sliding scrotal hernia sacs are transected at the midpoint of the canal, leaving the distal section in place. However, the anterior wall of the distal sac is incised to prevent postoperative hydrocele formation.

In the event of direct hernias, if large, the direct sacs are inverted with an absorbable suture (Fig. 3). A thorough exploration of the groin is necessary to rule out the coexisting intraparietal (interstitial) or femoral hernias. The femoral ring is routinely evaluated through the space of Bogros via a small opening in the canal floor. A precut sheet of 8 x 16 cm of mesh is used. We prefer monofilamented polypropylene meshes (such as Atrium, Marlex, Prolene and Trilex) because their surface texture promotes fibroplasia and their monofilamented structure does not perpetuate or harbor infection [Amid 1994]. The medial end of the mesh is rounded to the shape of the medial corner of the inguinal canal. With the cord retracted upwards, the rounded corner is sutured, with a non-absorbable monofilamented suture material, to the aponeurotic tissue over the pubic bone and overlapping the bone by 1 to 1.5 cm (Fig. 2). This is a crucial step in the repair because failure to cover this bone with the mesh can result in recurrence. The periosteum of the bone is avoided. This suture is continued as a running suture with up to five passages) to attach the lower edge of the patch to the shelving margin of Poupart's ligament up to a point just lateral to the internal ring. Suturing the mesh beyond this point is unnecessary and could injure the femoral nerve. If there is a concurrent femoral hernia, the mesh is also sutured to Cooper's ligament 12 cm below its suture line with the inguinal ligament to close the femoral ring (Fig. 3).

A slit is made at the lateral end of the mesh creating two tails, a wide one (two-thirds) above and a narrower (one-third) below.

The upper wide tail is grasped with a hemostat and passed towards the head of the patient from underneath the spermatic cord; this positions the cord between the two tails of the mesh (Fig. 4).

The wider upper tail is crossed and placed over the narrower one and held with a hemostat (Fig. 5). With the cord retracted downwards and the upper leaf of the external oblique aponeurosis retracted upwards, the upper edge of the patch is sutured in place with two interrupted absorbable sutures, one to the rectus sheath and the other to the internal oblique aponeurosis, just lateral to the internal ring.

Occasionally, the iliohypogastric nerve has an abnormal course and stands against the upper edge of the mesh. In those instances, a slit in the mesh will accommodate the nerve. Sharp retraction of the upper leaf of the external oblique during this phase of the repair is important because it achieves the appropriate amount of laxity for the patch [Amid 1995]. When the retraction

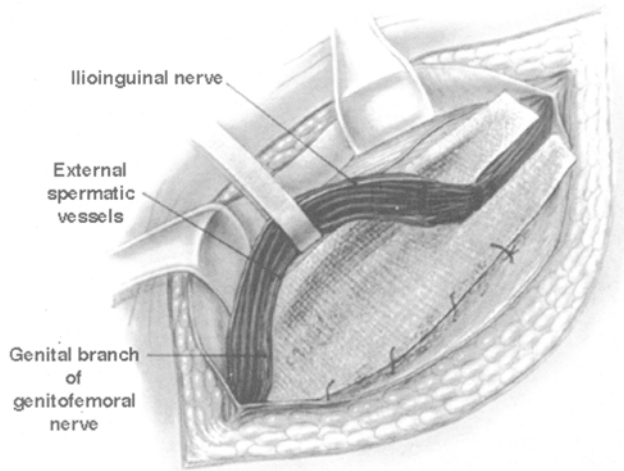


**Fig. 4**
Spermatic cord is placed in between the two tails of the mesh

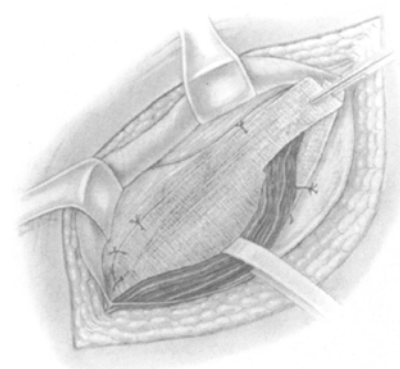

**Fig. 5**
Crossing of the two tails

**Fig. 6**
The lower edges of the two tails are sutured to the inguinal ligament for creation of a new internal ring made of mesh

is released, the mesh buckles slightly, and this laxity assures a true tension-free repair and is taken up when the patient strains on command during the operation or resumes an upright position.

Using a single non-absorbable monofilamented suture, the lower edges of each of the two tails are fixed to the shelving margin of Poupart's ligament just lateral to the completion knot of the lower running suture. This creates a new internal ring made of mesh (Fig. 6). The crossing of the two tails produces a configuration similar to that of the normal transversalis fascia sling, which is assumed to be largely responsible for the normal integrity of the internal ring. In addition, it results in buckling or sagittation of the mesh in this area and assures a tension-free repair of the internal ring area.

The excess patch on the lateral side is trimmed, leaving at least 5 cm of mesh beyond the internal ring. This is tucked underneath the external oblique aponeurosis (Fig. 6), which is then closed over the cord with an absorbable suture.

## Outcome measures

5360 inguinal hernias in 4360 adult male patients were repaired under local anesthesia at the Institute from 1984 to 1996. The series included 1000 bilateral inguinal hernias, which were repaired simultaneously under local anesthesia [Amid 1996] and 360 recurrent inguinal hernias (mostly since 1992). The age range of patients was 19 to 86 years. 44% of patients had indirect, 43.1% had direct, and 12.5% had a combination of indirect and direct inguinal hernias. 78% of patients were of normal weight or up to twenty pounds overweight. 20% of patients were 20 to 50 pounds overweight, and 2% were more than 50 pounds overweight. 27% of patients had bilateral inguinal hernias and 11.4% had sliding hernias.

With regard to employment, 60.2% had sedentary jobs, and 38.8% performed hard manual labor duties. Since early 1990's, this ratio has reversed because: a) less private patients (non-workers, compensation patients) were soon due to the expansion of managed care systems in California, and b) more workers' compensation patients were operated due to the increasing concern of employers and workers' compensation insurance companies for rapid return to work of the employees. The operative time, including the administration of local anesthesia was 20-45 minutes depending on the complexity of the hernia.

Ninety nine percent of the patients underwent outpatient surgery and the hospital stay after the operation was two to three hours. One percent of patients were admitted to the hospital because of unrelated medical or personal reasons. Analgesic requirement for postoperative pain was 0 to 20 (mean of 8) tablets of Vicodin (hydrocodone bitartrate 5 mg and Acetaminophen 500 mg) for a period of 1 to 4 days. Postoperative unrestricted activity was encouraged. Patients returned to their usual work activities with no restrictions between 2 to 14 days. There was one chronic postoperative neuralgia and no patient developed a seroma that required aspiration [Amid 1994]. Early in the evolution of this technique, four patients developed recurrences as a result of technical errors. Three hernias recurred at the pubic tubercle because of failure to overlap the bone with the mesh. One recurrence resulted from total disruption of the mesh from the inguinal ligament because the mesh was too narrow.

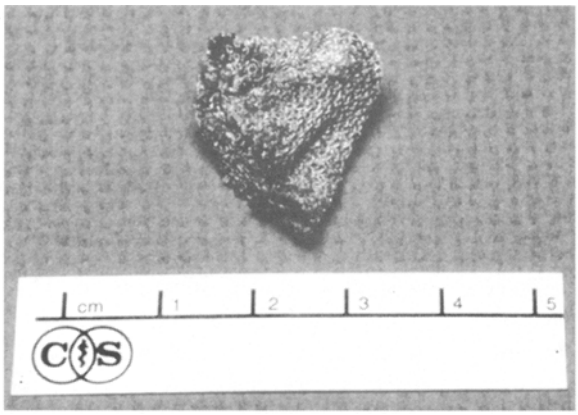


**Fig. 7**
Shrunken Perfix mesh plug herniated through the internal ring into the inguinal canal removed after its separation from the iliac vein

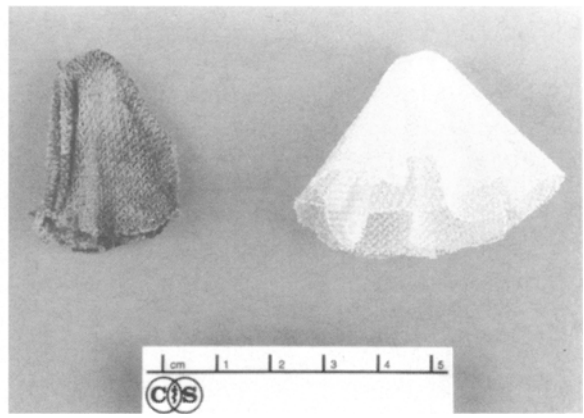

**Fig. 8**
Shrinkage of a "Perfix" mesh plug four months after its implantation (removed during an operation for recurrence of the hernia). There is 70% shrinkage compared with the unused plug and more than 30% shrinkage compared with the plug after its insertion into the Hernia defect

There has been only one recurrence in those patients operated on within the last six years [Amid 1994].

## Technical considerations

Reported recurrence rates by individuals or institutions are scientifically meaningless unless the method of follow-up is known and length of observation is sufficient. The only reliable method of follow-up is by physician examination. Written questionnaires and telephonic inquiries are notoriously unreliable and associated with 50% of inaccuracy [Abramson 1978, Panos 1992].

Short-term follow-up, particularly after mesh repair, solely reveals the therapeutic value of the repair [Amid 1995]. A long-term follow-up of 10 years or more is required to evaluate the therapeutic value of the repair as well as its prophylactic effectiveness [Amid 1995].

The use of a wide piece of mesh to overlap with tissues beyond the boundary of the Hesselbach's triangle for 3-4 cm is important to reduce the chance of recurrence. After incorporation is complete, this overlap results in uniform distribution of intra-abdominal pressure over the much wider surface of the overlapped area rather than just the line where the mesh is joined to the tissue. Because the mesh is placed behind the external oblique aponeurosis, the intra-abdominal pressure works in favor of the repair. The external oblique aponeurosis keeps the mesh tightly in place by acting as an external support when intra-abdominal pressure rises [Amid 1995, Shulman 1995]. Placement of the mesh underneath the transversalis fascia, (such as the Rives procedure) [Stoppa 1984] although a sound concept, requires unnecessary dissection and lead to excessive surgical trauma. In fact, a recent prospective and randomized study comparing Lichtenstein's repair with repair by placement of the mesh behind the transversalis fascia indicated no difference in the recurrence rate [Bonwich 1998]. In addition, the study concluded that the Lichtenstein's repair was easier to perform, teach and learn [Bonwich 1998]. Proper fixation of the margins of the mesh to the groin tissue is another important step in the prevention of recurrence. In mobile areas such as the groins, there is a tendency for the prosthesis to fold, wrinkle, or curl around the cord. More importantly, in vivo, mesh prostheses lose approximately 20% of their size due to shrinkage [Amid 1997]. The slightest movement of the mesh from the pubic tubercle, the inguinal ligament, and the area of the internal ring, due to the above factors, is a leading cause of failure of mesh repair of inguinal hernias. Adequate laxity of the mesh must be allowed during fixation to totally eliminate tension and compensate for the increased intra abdominal pressure that results when the patient stands or strains. A completely flat mesh with no ripple, in a patient under sedation and in a recumbent position, will be subject to tension in the standing position and with straining [Amid 1995].

With regard to recurrent inguinal hernias, our preferred method of repairing recurrent inguinal hernias was the mesh plug technique. The idea of the mesh plug technique was based on the assumption that the recurrent inguinal hernias occur through a single defect in an otherwise intact inguinal floor, requiring minimal dissection limited to the area of the defect for the repair. This assumption was proved wrong by Greenburg's study, which showed that 10% of the recurrent inguinal hernias consisted of more than one defect [Greenburg 1987]. Furthermore, insertion of a plug behind the transversalis fascia and into the small space of Bogros places the plug in close proximity with the iliac vessels. Figure 7 shows a collapsed preformed mesh plug (Perfix plug) herniated from the internal ring to the inguinal canal with its base firmly attached to the iliac vein requiring operative room consultation with a vascular surgeon for its removal. In addition, erosion of the plug into the iliac artery has been reported [Cristaldi 1997]. Therefore because of the failure of the mesh plug repair due to 1) missing a second defect as a result of inadequate dissection, 2) failure of the repair due to shrinkage of the plug [Amid 1992, 1997] (Fig. 8), and more importantly 3) due to serious complications such as migration of the hard and abrasive shrunken plug into the inguinal canal (Fig. 7), scrotum and

erosion of the plug into the bladder [Amid 1992, 1997], intestines [Danielli 1997] and iliac vessels [Cristaldi 1997], in 1996, the mesh plug repair was completely abandoned and all recurrent inguinal hernias were repaired by the tension-free patch technique, similar to the repair of primary inguinal hernias.

Use of the tension-free technique in conjunction with local anesthesia has drastically reduced the hospital stay, postoperative discomfort, recovery period, recurrence rate and the cost of hernia surgery. Since its introduction, the open tension-free hernioplasty has been employed by many surgeons around the world [Bocchi 1995, Capozzi 1997, Davies 1994, Horeyseck 1996, Kark 1993, Kux 1994, Martin 1984, Rutten 1992, Tinkler 1985]. In fact, a recent survey in England showed that 70% of British surgeons are now employing the Lichtenstein "tension-free" method of hernia repair. A survey of 70 surgeons with no special interest in hernia surgery, who had done 22,300 Lichtenstein open "tension-free" hernioplasties gave similar results [Shulman 1995].

The fact that extensive experience or expertise with the method have not been considered necessary for excellent results [Wantz 1997] is a testimony to the simplicity, safety, and effectiveness of the open "tension-free" hernioplasty. Furthermore, the procedure yields itself to modification according to the operator's personal choice and situational requirements.

The procedure is simple and safe and achieves all the goals of modern surgery, such as more comfortable postoperative course and rapid return to unrestricted activities, with a recurrence rate of virtually zero (0.1% from early operations). It also avoids the need for general anesthesia and invasion of the peritoneal or preperitoneal spaces and their associated complications.

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