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# Chronic Pain Following Inguinal Hernioplasty

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The desire for a material to block the passage of an inguinal hernia may have originated with Billroth (Christian Albert Theodor Billroth, 1829–1894), who in 1878 expressed the wish that "if an ideal tissue replacement could be found, the problem of hernia would no longer exist."[1] He was right of course, but the fulfillment of his wish remains elusive.

Edoardo Bassini (1844–1924) introduced a brilliant triple-layer reconstruction (internal oblique muscle and transverse and transversalis fascia secured with the filzetta stitch) of the inguinal canal for the "radical" cure of hernia very soon thereafter in 1894.[2] He reported a low infection and recurrence rate. Unfortunately, Bassini's principles of hernia repair—a triple layer repair—did not become known in detail outside of Italy until 1890 and then it was known only in an incomplete sense. There were many modifications—corruptions really—of the original Bassini procedure, none the equal of the original.

Meshes composed of various materials and woven soft metals were tried but abandoned in the early 20th century because of tissue reaction, metal fatigue, and fragmentation.

A significant advance with widespread surgical implications occurred in 1935 when Dupont chemist, Wallace H. Carothers (1896–1937), discovered a method of creating synthetic polymers and was subsequently credited with the development of nylon. Two other chemists, Karl Ziegler (1898–1973) and Giulio Natta (1903–1979), were subsequently awarded the 1963 Nobel Prize in chemistry for their work on the polymerization of olefins. The discoveries of these scientists set the stage for development of other relatively inert polymers including polyester and polypropylene, which found their way into many commercial and surgical uses.[3]

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It is little known, but Don Aquaviva of France, in 1944, was probably the first to use synthetic (nylon) mesh to repair inguinal hernia and eliminate the suture-line tension inherent in pure tissue repairs. Aquaviva did not buttress a potentially weak tissue repair, but rather left the hernia defect intact and secured the inguinal region with mesh. Although these concepts of a tension-free prosthetic repair were published in France, the world paid little attention.[4–7]

The same might be said of Henri Fruchaud, another French surgeon, who presented a similar version of a tension-free repair. In his 1956 textbook that focused on inguinal anatomy, inguinal hernia, and inguinal hernia management, Fruchaud[8] suggested that a nylon mesh be anchored above the transverus abdominus/internal oblique and below the ligament of Cooper and femoral sheath—an operation that would become known as the Rives repair of inguinal hernia. The result: a tension-free repair. Again, the world paid little attention.

However, things began to change when Francis Cowgil Usher (1908–1980) helped launch the modern era of hernia repair with his 1959 report on the use of Marlex mesh to replace tissue defects.[9] This development was followed by Irving L. Lichtenstein's (1920–2000) innovative concept of a "tension-free" repair of inguinal hernia with prosthetic mesh.[10] Local anesthesia was administered, and no formal reconstruction of the inguinal region was performed. Rather, in his repair, direct and indirect inguinal sacs were inverted and a polypropylene implant was sutured to Poupart's ligament below and to the rectus sheath and conjoined muscle and tendon above. No attempt was made to reconstruct the inguinal canal. In this way, the major openings of inguinal hernia were bridged by prosthetic screen, avoiding suture line tension, the *bête noir* (bugbear or black beast) of hernia surgeons.

Before proceeding further, it is useful to define terms that describe the several hernia procedures in common use:

*Herniotomy* refers to ligation and excision of the hernia sac without reinforcement of the inguinal wall or displacement of the spermatic cord. Primarily used in pediatric patients.

*Herniorrhaphy* includes reinforcement of the floor of the inguinal canal with the patient's tissue and/or transposition of the cord, in addition to high ligation of the sac.

*Hernioplasty* involves the addition of grafts or prosthetics to herniorrhaphy.[10]

The Lichtenstein procedure was easy to understand and demanded little in the way of surgical skill. It could be performed in remote areas under local anesthesia with little technological support. And, most important, it reduced the incidence of hernia recurrence for the surgeon with modest experience in hernia repair. Little wonder that it achieved worldwide acceptance and support.

It must be said that major contributors to the 20th century literature before the widespread adoption of Lichtenstein's technique listed hernia recurrence as the major complication of hernia repair. They typically reported inguinal hernia recurrence rates in the neighborhood of 10%, although the actual rate was likely much higher, perhaps in the range of 10–30%.[11]

Chronic pain, as a complication of pure tissue repair of inguinal hernia, on the other hand, was an unusual occurrence in the decades preceding large-scale use of prosthetic mesh. The incidence of pain following open repair without mesh was usually related to the entrapment of a nerve by suture or the formation of a neuroma following section of a nerve.[12,13] Postinguinal herniorrhaphy pain rarely rated more than a sentence or two in major textbooks.

Complications of hernia repair have changed dramatically since the widespread introduction of synthetic mesh for repair of inguinal hernia. Current literature suggests that hernia recurrence following repair with mesh is quite low, varying between 0 and 1.7%.[9] Chronic pain, defined as pain persisting beyond the normal tissue healing time of 3 months, however, has increased dramatically.[14] Chronic posthernioplasty pain is now one of the most common complications following inguinal hernia repair. The incidence of disabling chronic pain 1 year after surgical repair was reported to be approximately 11% by the Danish Hernia Data Base group in 2001.[15] More recently, Reinpold et al[16] reported a 16.5% incidence of chronic pain 6 months after surgical repair.

Most would agree that the ideal mesh characteristics for repair of inguinal hernia include the following and not include symptoms resulting from use of mesh itself:

1. Not be modified by tissue fluids,
2. Be chemically inert,
3. Not excite an inflammatory or foreign body reaction,
4. Be noncarcinogenic,
5. Not produce an allergic or hypersensitivity reaction,
6. Resist mechanical strain,
7. Be capable of being fabricated in the form required,
8. Be capable of being sterilized,
9. Resist infection,
10. Provide a barrier to adhesions,
11. Respond in vivo like autologous tissue.[17]

A 12th characteristic might be that the mesh be easily removed whenever a problem such as pain or infection develops.

Robert Bendavid and colleagues[18,19] have explored this trend of progressive chronic pain syndrome after inguinal hernioplasty in several elegant papers and have provided insight into the complex mechanism of chronic pain development after mesh repair of inguinal hernia.

Essentially, Bendavid has taken advantage of the wealth of potential scientific information hidden on and within the interstices of explanted mesh removed for recurrence or to alleviate inguinodynia—chronic inguinal pain.

Far from being an ideal, autologous-like tissue not modified by tissue fluids or chemically inert explanted hernioplasty mesh screens have been found to undergo shrinkage, loss of pliancy, and increased rigidity; to foster chronic infection; to cause dysejaculation; and to transmigrate into adjacent structures including vascular, muscular, and cutaneous violations.[18] To add to this litany of woes, the most common of synthetic mesh consequences has been the emergence of symptomatic pain—chronic pain that occurs greater than 3 months after surgical intervention and interferes with work or leisure.

The cause of chronic pain after inguinal hernioplasty is not well understood. Nonetheless, Bendavid has helped shine a light on the puzzle and provide meaningful insight into this issue. Briefly, severed nerve fragments have been shown to attempt reinnervation of their domain by developing branches that can grow into the interstices and pores of explanted mesh samples. This reaction is thought to be an evolutionary response to restore the integrity of sensation in an injured area. These branches can be 1 mm in thickness or of the smallest diameter, visible only with a microscope, and extend a significant distance from the injured nerve trunk.[18]

For this reason, it is difficult, if not impossible, to denervate an area such as the groin after the initiation of mesh-induced inguinodynia. Triple neurectomy of the iliohypogastric, ilioinguinal, and genital femoral nerves comes to mind.

More to the point, Bendavid and his associates found that the nerve density, ingrown into explanted meshes removed for chronic pain, exhibited a marked increase in

amount over mesh explanted for recurrence. They hypothesize that, since the ingrown nerve branches were small, the ingrowth was likely driven by nonspecific tissue repair factors. Nevertheless, these nerve branches are subject to all known physical and chemical pain mechanisms and would respond to these noxious stimuli in a manner similar to other sensory nerves. Underlying all of these responses is the teleological fact that nerves have evolved as the earliest and most delicate sensors of an injurious environment.[18]

In a similar vein, these investigators explored nerve entrapment associated with postherniorrhaphy and postherniоplasty pain in another study. The mechanism of pain in these instances was felt to be due to microentrapment and microcompartment syndromes through new nerve and vessel ingrowth into mesh pores and other confining spaces such as the smaller compartments associated with tight weave and knit patterns. The presence of vessels in these compartments is a risk factor for fluid and hemodynamic abnormalities. External pressure along with mesh deformation and shrinkage could lead to edema with raised microcompartment and microentrapment pressures causing an acidic, hypoxic environment.[19]

All in all, the above leaves much food for thought. According to the National Center for Health Statistics, well in excess of 500 000 inguinal hernia operations are performed each year in the United States.[20] In nearly all—open and laparoscopic—the surgeon uses synthetic mesh as the principal component of repair. If the incidence of chronic pain after mesh repair approximates 16.5%, then a very significant number of patients will have debilitating pain resulting from the procedure when most patients likely had little or no preopertive pain.

This possibility presents a potential time bomb for the surgical community and medical device suppliers. Hernia recurrence has been largely reduced by the use of synthetic mesh for repair, but a new problem, chronic postoperative pain, has arisen to rival recurrence as a serious consequence of surgical intervention. The surgical community, as well as the industry that garners huge profits from the use of synthetic materials must address this troubling issue. The evidence is mounting that mesh, which was generally thought—and promoted—to be inert, now appears not to be so.

There is not a single approach for the surgical correction of inguinal hernia based on current techniques and understanding. Rather, each patient must be considered individually and his or her symptoms explored in depth. In some cases of hernia, there is no need for intervention. Moreover, each surgeon must be extremely cognizant of the limits of his or her skill and technical resources.

From all that we know, a successful outcome for the Shouldice or Bassini repairs requires a complete knowledge of surgical anatomy, respect for tissue, reduction of tension (use of continuous suture, filzetta stitch) and thorough knowledge of the principles that undergird these procedures.[2] That they can be performed with relatively simple tools and local anesthesia are strong factors in their favor. Recurrence, the previous bane of hernia surgeons, is quite low in skilled hands. But, these procedures require a trained surgeon dedicated to a mastery of anatomic knowledge and gentle technique.

On the other hand, the Lichtenstein procedure requires little in the way of in-depth anatomical knowledge. It is simple and fast. Just open the inguinal canal, reduce the hernia(s), and place synthetic mesh over the direct and inguinal openings, and all is complete. However, as noted above, a large number of patients (perhaps 16% or so) will develop significant postoperative pain. Careful dissection of the inguinal canal with uncovering of the iliohypogastric, ilioinguinal, and genitofemoral nerves does not mitigate the fact that these nerves are exposed and subjected to the interposition of a foreign body (synthetic mesh).

A laparoscopic approach to inguinal hernia repair, while requiring laparoscopic skills, does offer a thorough exposure of Fruchaud's "myopectineal orifice" and an opportunity to cover all potential defects in the abdominal wall for inguinal and femoral hernia.[8,21] This approach is particularly useful for repair of inguinal hernia recurrence after an open approach. However, there are numerous drawbacks to this technique, including the requirement for general anesthesia, long operative time, specialized instruments, trained operating room staff, long learning curve, and a technically skilled operator. In addition, if preperitoneal mesh requires explantation, it can be most difficult to remove, and removal is usually incomplete. None of these reduce the usefulness of a laparoscopic approach, but they highlight potential obstacles in its universal application.

It seems that a solution to these issues will require a nuanced, multilayered approach. To begin with, surgical training programs will need to apply more focus on emphasizing anatomic knowledge and physiologic function of the groin. This information should be incorporated into the written and oral board examinations. In addition, to satisfactorily complete a surgical training program, train-

ees should perform a minimum number of pure tissue hernia repairs (proven to be effective with low recurrence rates), along with repairs that use prosthetics.

Some responsibility also should be taken by device manufacturers that have widely promoted surgical mesh and have derived great economic gain from the extensive use of mesh for hernia repair. The involvement and degree of accountability of industry should be considered at the highest levels of those involved with surgical education along with input from surgical ethicists and practicing surgeons. Industry must be involved in the solution, as they are part of the problem.

Considering the above, it is apparent that there is no single "right" way to repair inguinal hernia with present day knowledge and techniques. Each patient is an individual with a correctable surgical disease. The correction, however, can take one of many different forms and may carry with it Robert K. Merton's "Law of Unintended Consequences"[22]— an unforeseen complication (ie, postinguinal hernioplasty pain) that is an outcome not intended by the correction (ie, the use of mesh). Therefore, any intervention must be tailored to the individual, with full preoperative disclosure of all potential complications and consideration given to the skills and resources available to the individual surgeon.

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