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History of the Inguinal Hernia Repair

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<http://dx.doi.org/10.5772/58533>

1. Introduction

1.1. Early attempts at the treatment of inguinal hernia

The inguinal hernia is one of the diseases that haunted the humanity from its very beginning to the modern times. The currently used term „hernia” comes directly from ancient Greece: (kele/hernios in Greek means bud or offshoot). Although the natural course of the disease is relatively slow it eventually reaches the size that severely impairs the patient ability to perform daily activities (Figure 1). That is why already in antique times the surgeons and physicians alike were trying to find the solution for this highly disturbing condition. The mainstay of treatment remained the use of different types of inguinal belts that were supposed to maintain the hernia sac inside the body cavity. To successfully apply the herniary belt the hernia was first manually reduced (Figure 2) and then, the herniary belt, often custom made for a particular patient, was applied. The use of hernia belts was widespread and even today it can be found in some regions of the world.

The wide popularity of the belts was maintained because the surgical option for the cure of inguinal hernia was extremely dangerous and unfortunately not very convincing. One of the first attempts to solve inguinal hernia by the means of surgical knife came from the famous XVIth century Italian anatomist, Gabriele Fallopio. Fallopio proposed wide excision of the sac with surrounding skin and all its contents, securing the neck with an impressive suture (so called the golden stiiich). The technique did not become very popular among patients because it resulted in castration and sometimes in the permanent stoma from the cut intestinal loop. The risk of death from bleeding and peritonitis was also important limiting factor of this technique [1]. This is why many barber-surgeons of that time suggested that the operation should be considered „only for marked hernias, which could not be held even with the strongest and surdiest bands at their right place” [2].

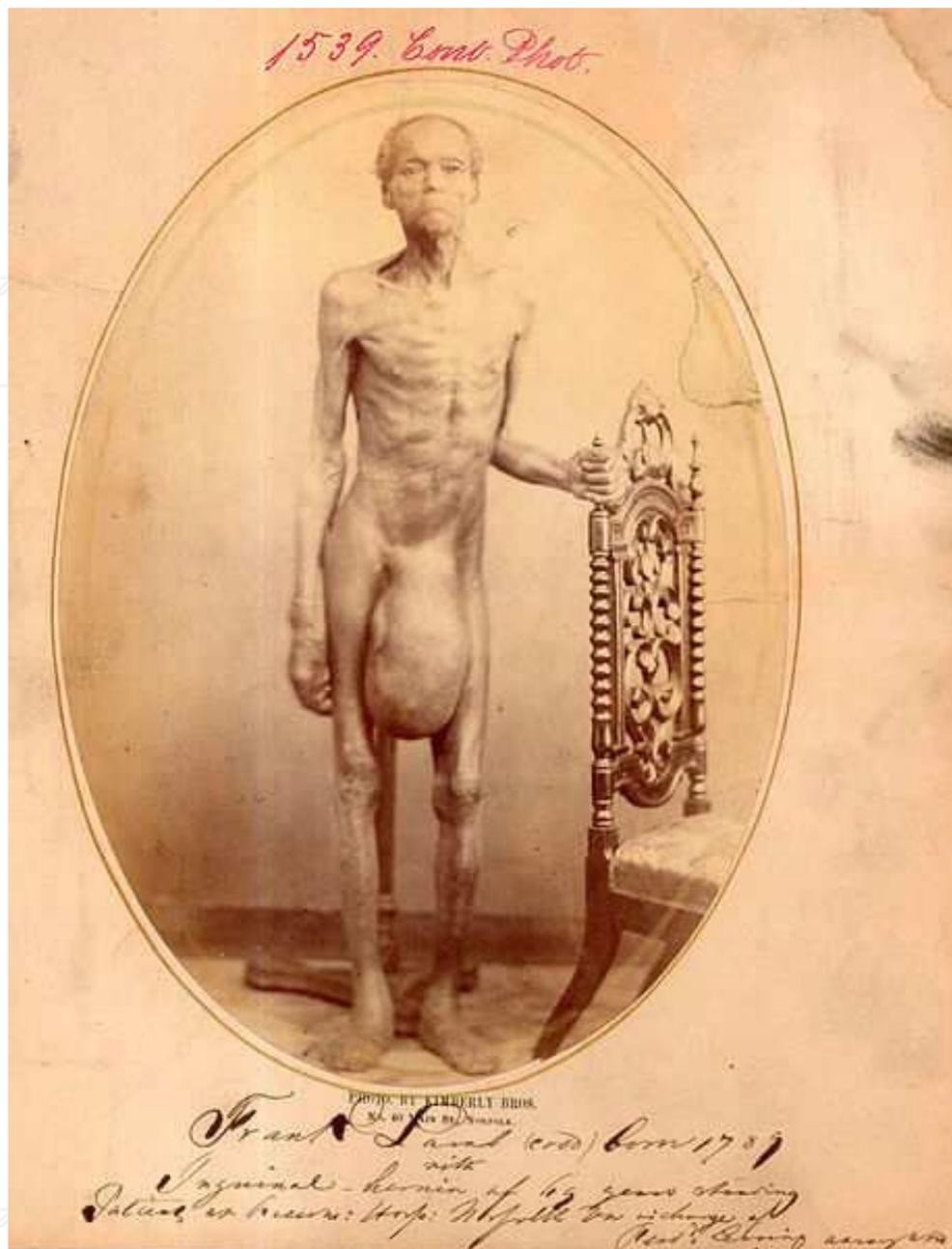


Figure 1. A man with a 69 years history of inguinal hernia. The patient, Frank Lamb, was a slave in North Carolina and since he was 9 years old suffered from left inguinal hernia. Nevertheless he was forced to hard, daily labor. As a result an important inguino-scrotal herniary sac developed. From: Otis Historical Archives of "National Museum of Health and Medicine".

Another worth noticing attempt at giving surgical solution to the inguinal hernia was done by Claudius Amyand from London who in 1735 operated on an 11-year-old boy. The patient suffered from a right inguinal hernia complicated by a faecal fistula. The operation performed by Claudius Amyand is important for two reasons. Firstly, it is the earliest description of a hernia containing a vermiform appendix (known today as Amyand's hernia). And secondly, it is the earliest documented appendicectomy in the history of surgery. On the other hand it

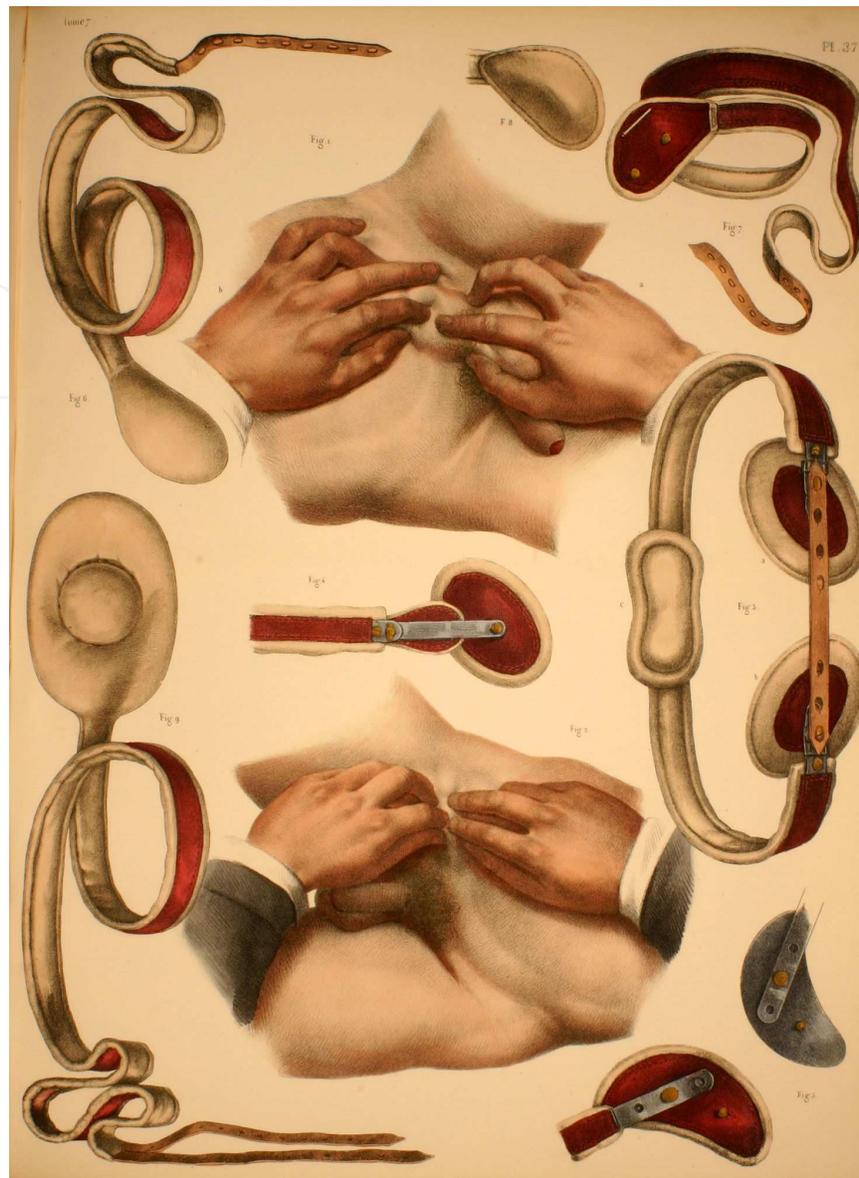


Figure 2. Manual reduction of the inguinal hernia and the use of herniary belts. Image courtesy: BIU Santé (Paris) <http://www.biusante.parisdescartes.fr/histmed/image?med02083x07ax0493>

shows us that the decision to operate on a hernia patient was made when surgeon was facing a complex problem that required a daredevil solution [3].

The anatomical knowledge of human body was still evolving in XVIIIth century. Some advances of the treatment of inguinal hernias, especially incarcerated hernias that posed direct danger of death to the patient if not reduced or operated on has been made in this era. The Spanish anatomist and surgeon Antonio Gimbernat y Arbos after studying anatomy of inguinal canal witnessed an anatomical presentation in London in 1777, performed by famous John Hunter. Gimbernat noticed that Hunter experienced problems in reducing a femoral hernia so he stopped the presentation and told Hunter to cut ligamentum lacunare and this way open femoral canal. After a moment of reflexion Hunter replied: „You’re right Sir. I will

operate on femoral hernia only in this way from now on." Once again, we have to bear in mind that hernia operations in this era were rare and limited to very desperate, live-or-death situations [4].

1.2. New trends in XIXth century

The fast evolution of medicine and surgery in the XIXth century gave way to some new ideas in the treatment of inguinal hernia. The introduction of antisepsis, asepsis and anesthesia allowed for safer procedures. The advances in anatomical knowledge of hernia lead to the introduction of two important rules for hernia surgery: high ligation of hernia sac and narrowing of the internal inguinal ring. Among techniques that received some fame among XIXth century surgeons we should mention the techniques of William Wood, Vinzenz Czerny and James Heaton. Heaton was performing injection of the mixture of white oak and morphine into the hernia sac to obtain its fibrosis [5]. Czerny was performing the high ligation of the hernia sac and complete closure of the internal inguinal ring with sutures [6]. In the Wood's method the surgeon was supposed to double ligate herniary sac to perform a natural „plug" and use it to close internal inguinal ring [7]. Unfortunately although these techniques looked appealing at first, in the long term virtually all patients experienced hernia recurrence [5]. Let us also remind the reader that the mortality after these operations was reported to be as high as 7% [8].

2. The revolution of Edoardo Bassini

„In order to achieve a radical cure of hernia it is absolutely essential to restore those conditions in the area of the hernial orifice, which exist under normal conditions"-Edoardo Bassini.

It wasn't until 1887 that the real breakthrough in the treatment of inguinal hernia came. All started with a young student from Pavia University, Edoardo Bassini entering in the ranks of Giuseppe Garibaldi's army. During the battle against papal guards near Villa Glori in Rome, Bassini received a bayonet wound in his right groin. After remaining unconscious in the battlefield for several hours he finally recovered only to find out that the bayonet has penetrated the intestinal wall and the coecal fistula has formed within the wound. He turned for help to his university professor Luigi Porta and remained a patient in Pavia for almost 6 months. The coecostomy finally closed but during that time Bassini studied extensively the anatomy and physiology of the inguinal region. Afterwards he started to perform inguinal hernia operation with the techniques of Wood and Heaton but all operated hernias recurred. At this point Bassini realized that the problem was more within the diseased anatomy and physiology of the inguinal canal than in the technique itself. Therefore he come up with the idea that only complete reconstruction of the anatomy of the inguinal canal can lead to a full recovery from inguinal hernia [5]. The meticulous anatomical knowledge led to a surgical technique that Bassini applied with important success to his patients in Padua, where he started to practice after graduation. Bassini has presented his first results in Padua in Italian during surgical congress in Genoa [9] and after a few years in German to gain a wider audience [10].

Within few years his original method (Figure 3) become a classic. His achievement is even more impressive if we realize that all subsequent methods of inguinal hernia surgery until introduction of artificial materials were in fact variants of Bassini concept. The popularization of the Bassini technique was so successful because it was a breakthrough concept but also because Bassini's pupils (among them Attilio Catterina) have done a lot to promote his achievements [11].

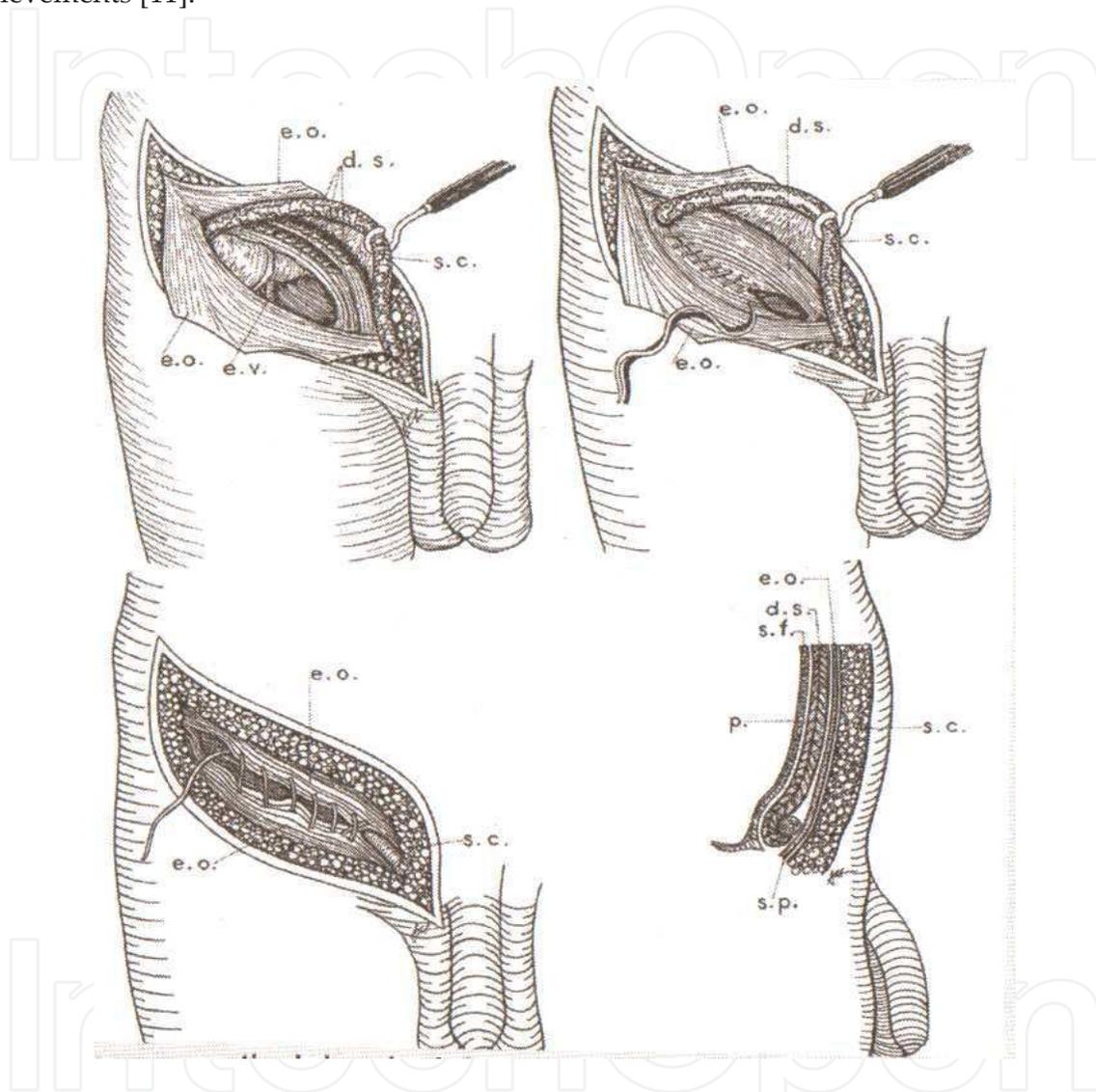


Figure 3. The schematic drawing of the Bassini technique from the German version of his original publication: Ueber de bechandlung des Leistenbruches. Archiv fur Klinische Chirurgie 1890;40:429 [10]

2.1. William Steward Halsted's method and other variants of Bassini's approach.

The main difference of Halsted proposition from Bassini method was the localization of the spermatic cord. After reconstructing the inguinal canal Halsted was leaving spermatic cord in the subcutaneous position. It allowed for closure of the posterior wall of the inguinal canal with a very strong, transfixing sutures. Unfortunately among the first five patients operated by Halsted himself, one developed urinary fistula due to too deep transfixing sutures that

pierced through urinary bladder wall. The fistula eventually closed but it showed clearly the risk of too deep sutures placed in the transverse fascia and in the preperitoneum [12].

The subcutaneous position of the spermatic cord exactly as in the Halsted's method was applied also in several other modifications proposed by several surgeons in the years to come. Among them we would like to cite a method described by Paolo Postempski from Rome (Figure 4) [13].

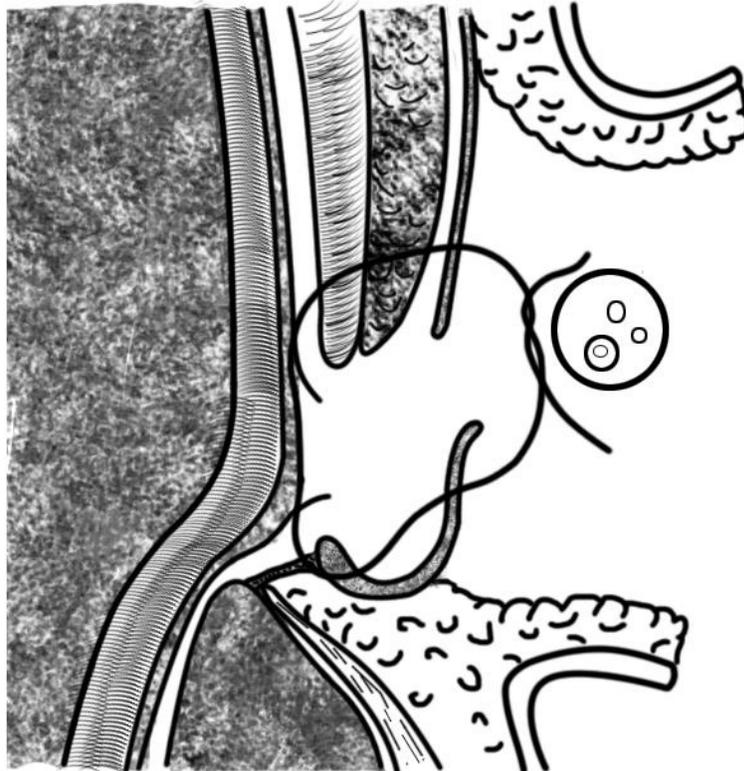


Figure 4. Schematic representation of the Postempski repair. Note subcutaneous position of the spermatic cord as in the Halsted's method. Drawing by dr Jerzy W.Mituś based on Gangeri G. *Risorse in chirurgia generale*. Kofler Editore, Bassano del Grappa 2006 [12].

Among many variants of Bassini method it would be also interested to mention „The Polish technique” developed by Zdzisław Sławiński in Warsaw and popularized during the World War I. It has gained important fame especially after Sławiński operated with success on cardinal Achille Rattii who later become pope Pio XI. The peculiarity of this technique consisted on dissecting only the neck of the hernia sac, ligating and cutting it and leaving the cut sac „in situ” [14].

At the advent of World War II Chester McVay from Ann Arbor popularized his concept of inguinal hernia repair using Cooper's ligament instead of inguinal ligament as a lower edge of sutures aimed at reconstructing posterior wall of the inguinal canal. In McVay's opinion the use of inguinal ligament by all his predecessors was a „fundamental error” that has led to high hernia recurrence rate [15].

Probably the last big step in the evolution of the „tension” repairs of inguinal hernias was the method described and mastered over the years by Edward Earl Shouldice from Toronto. His idea started in the fifties and was slowly evolving to reach a very mature technique. Shouldice advocated meticulous dissection, complete incision of the transverse fascia, sutures with monofilament rather than silk, oversewing of the posterior wall of inguinal canal by four layers of fascia and aponeuroses of oblique muscles and finally rapid ambulation of the patient (patient were walking home after 2-3 days when at that time it was customary for other surgeons to retain their hernia patients up to 3 weeks in bed). Interestingly there exist no single description of the technique published by Shouldice. Apparently, Shouldice thought that all those willing to learn his technique should come to Toronto and see him performing the famous „Canadian repair”. Indeed, the 3% hernia recurrence rate in Shouldice Hernia Hospital was impressive at the time when majority of hospitals experienced even 20% of hernia recurrence. The Shouldice repair can be seen as a final, close to perfect state of Bassini method. As Robert Bendavid stated: “The Shouldice repair, which on occasion is referred to as the Canadian operation, is a derivation of the Bassini repair and incorporates succinct changes, which must be appreciated. It will become evident why Earle Shouldice can be considered the heir to Bassini and to have enhanced that envious stature” [16].

At the advent of wide availability of prosthetic materials the tension repairs have seen a major decline in their use. However, several surgeons see the classic techniques as an interesting and viable option for a selected group of hernia patient. The most popular techniques used until recently (and in some cases even today) include the Bassini, Postempski and Shouldice operations [17]. The major developments in the history of tension repairs of inguinal hernia are shown in the Table 1.

Author	Year	Technique
Edoardo Bassini	1887	reconstructing the anatomy of the inguinal canal
William Steward Halsted	1889	subcutaneous position of the spermatic cord
Paolo Postempski	1890	subcutaneous position of the spermatic cord and closure of external inguinal ring
Zdzisław Sławiński	1916	herniary sac left „in situ”, the neck of the sac used to close internal ring
Chester McVay	1942	Cooper’s ligament instead of inguinal (Poupart’s) ligament for the reconstruction
Edward Earl Shouldice	1953	incision and reconstruction of the transverse fascia

Table 1. Major developments in hernia repair without use of artificial materials (tension techniques)

3. The tension-free era

The second single biggest step in the history of inguinal hernia surgery came when Theodore Billroth’s dream came true. In the XIX-th century Billroth stated that: „If we could artificially

produce tissues of the density and toughness of fascia and tendon, the secret of radical cure radical cure of hernia would be discovered." If Bassini idea was to reconstruct completely the inguinal canal, it was the availability of modern prosthetic materials that let perform this reconstruction in a best possible way.

The introduction of first artificial materials that could be used to reinforce herniary defect date back to 1944 when nylon has been introduced. Although the first experiences were not very promising in the years to come several new materials have been patented and become commercially available: in 1958 polietylene, in 1959 politetrafluoroetilene (PTFE) and in 1963 goretex.

Apart from many small details that differentiate various tension-free (i.e.: with some kind of mesh implant) techniques the fundamental is the position of the mesh. In general the terms „onlay” and „sublay” were in reference to the position of mesh in relation to posterior wall of the inguinal canal. The „onlay” technique (Figure 5) consist on placing the mesh superficially to posterior inguinal canal wall and „sublay” position requires formation of space for mesh in the preperitoneal space (Figure 6 and Figure 7). The more popular „onlay” techniques include the modifications by: Lichtenstein, Gilbert, Rutkow-Robbins, Trabucco, Valenti as well as PHS-Prolene Hernia System method.

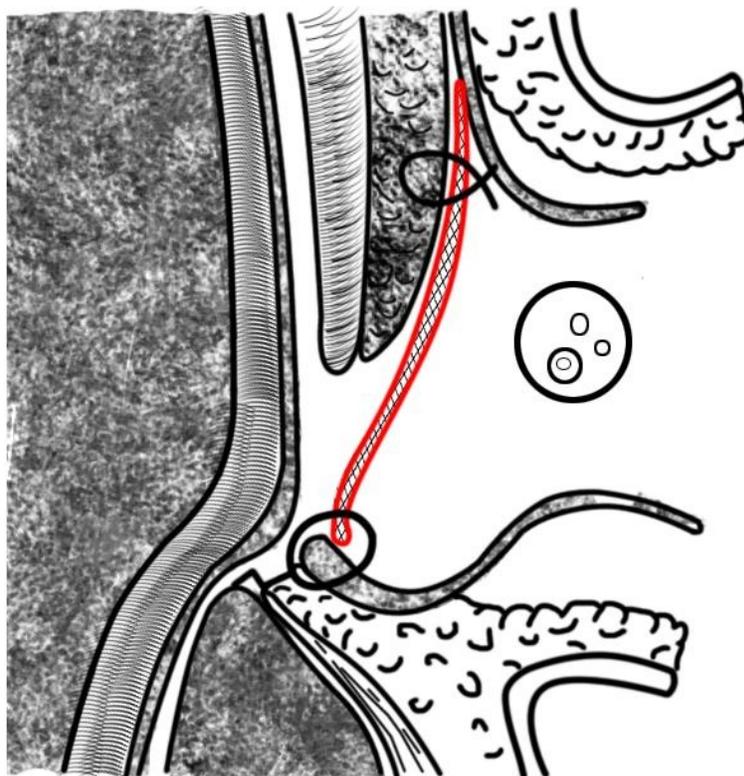


Figure 5. The “onlay” position of the mesh (in red); here in the Lichtenstein repair. Drawing by dr Jerzy W.Mituś based on Gangeri G. Risorse in chirurgia generale. Kofler Editore, Bassano del Grappa 2006 [12].

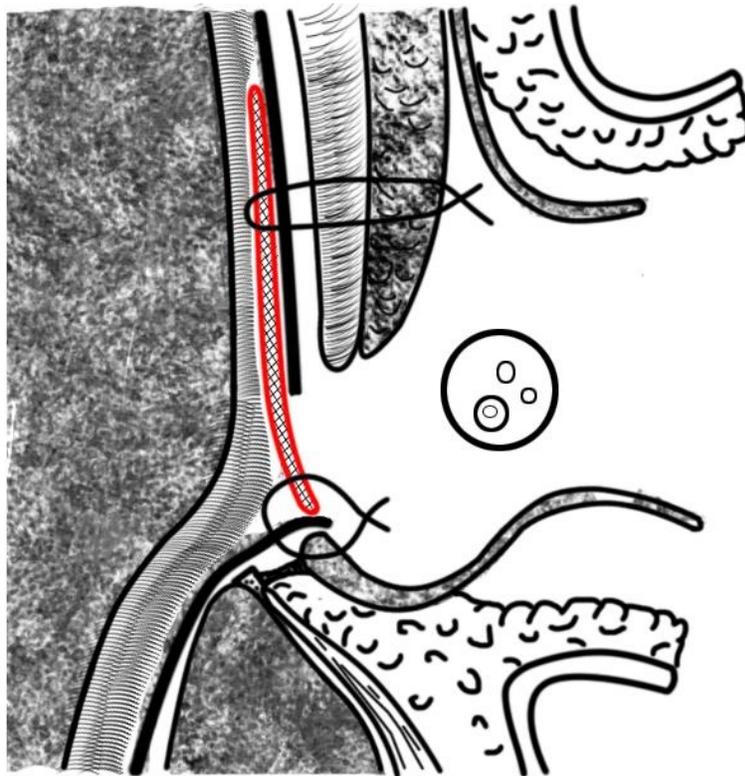


Figure 6. The “sublay” position of the mesh (in red). Drawing by dr Jerzy W.Mituś based on Gangeri G. *Risorse in chirurgia generale*. Kofler Editore, Bassano del Grappa 2006 [12].

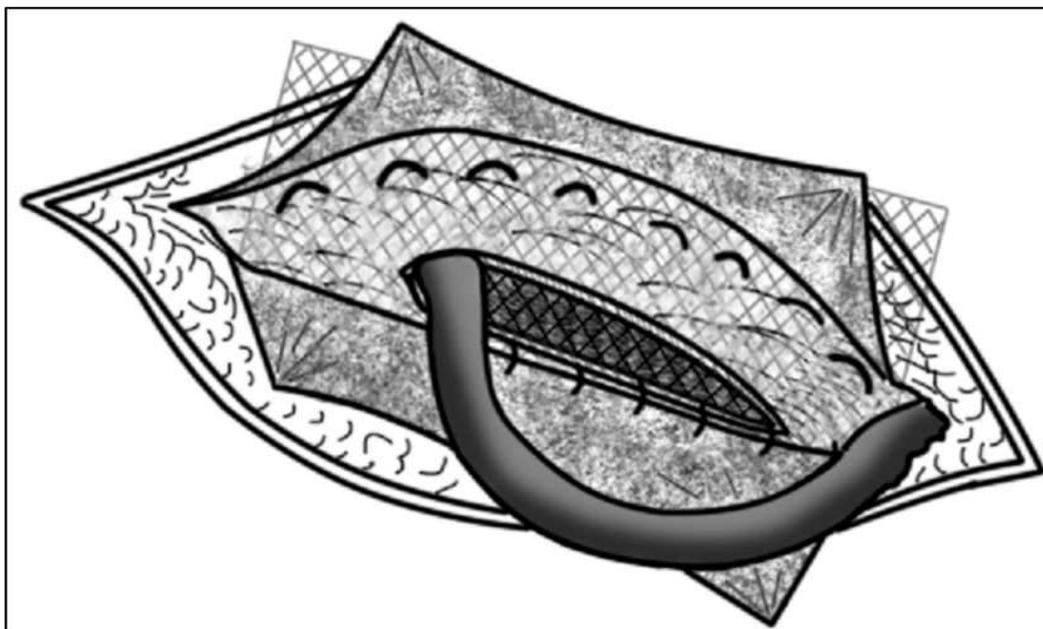


Figure 7. The “sublay” position of the mesh as seen upfront. Drawing by dr Jerzy W.Mituś based on Gangeri G. *Risorse in chirurgia generale*. Kofler Editore, Bassano del Grappa 2006 [12].

Initially the idea was to use the mesh to reinforce the posterior wall of the inguinal canal after performing a standard repair as in „tense” repairs. For example in the technique described in 1959 by Francis Usher the defect was reconstructed as in the Bassini operation and the Marlex (polietilene) mesh was placed on the reconstructed posterior wall to reinforce the approximated tissues [18].

It wasn't until 1984 when Irvin Lichtenstein from Los Angeles proposed repairing the posterior wall of inguinal canal with mesh without previous incision and reconstruction. In his own words: „There is evidence that to incise a strong posterior layer and, then, to reconstruct it as in the Bassini, Shouldice or McVay repair is inappropriate, disruptive and even meddlesome. The application of a wide sheet of harmless prosthetic mesh, one which serves only to strengthen such a floor, is harmless and should reduce the incidence of recurrences” [19]. And indeed the results of Lichtenstein repair were excellent: in a first 1000 patients operated by Lichtenstein and followed 5 years after surgery there weren't a single case of recurrence. It was truly a remarkable result and this is clearly one of the reasons the Lichtenstein repair is popular until today.

It was also Lichtenstein who introduced the concept of „cigarette” plug made from marlex mesh to repair femoral defect. This concept has been further developed by Arthur Gilbert from Miami who proposed preparing a cone from mesh and introducing it through the hernial defect without the use of sutures. This technique finally developed further when Ira Rutkow and Alan Robins from New Jersey described repair with both mesh (as in Lichtenstein repair) and plug (as in Gilbert technique). At first the technique coined „plugstein” was performed without sutures to finally reach a phase with the use of fixating sutures [20].

More recently in 1999 Arthur Gilbert described a technique that allows to place a mesh both in „onlay” and „sublay” position. His Prolene Hernia System (PHS) consisted on introducing a sophisticated mesh build from two meshes of different shape connected with a small tube. This allowed to reinforce the posterior wall of the inguinal canal both from preperitoneal site and from the „onlay” position [21]. In Table 2 the most important steps in tension-free repair can be observed.

Author	Year	Technique
Francis Usher	1959	reinforcing Bassini technique with mesh
Irvin Lichtenstein	1984	placing the mesh to reinforce the posterior wall of the inguinal canal
Arthur Gilbert	1987	cone-plug to cover defect
Ira Rutkow and Alan Robins	1998	mesh and plug repair
Arthur Gilbert	1999	Prolene Hernia System

Table 2. Techniques in tension-free repairs

4. Preperitoneal repair

In 1969 Rene Stoppa from Amiens developed a technique of GPRVS (giant prosthetic reinforcement of the visceral sac). This technique was supposed to be applied to large, complicated and bilateral inguinal hernias and consisted on implanting a large polyester mesh in preperitoneal connective tissue between the peritoneum and *fascia transversalis*. The incision of choice for preperitoneal access was a low midline incision and the mesh need not to be fixed with sutures due to its size and intraabdominal pressure maintaining it in situ [22]. Another preperitoneal hernia repair was described in 1976 by Lloyd Nyhus from Chicago. Unlike in the Stoppa method the incision was made above the inguinal ligament. A similar incision was used also for a preperitoneal placement of a sutureless mesh by Robert Kugel from Olimpia in his technique described in 1999 and coined Kugel Hernia Patch [23].

5. Laparoscopic hernia operations

The advent of minimally invasive techniques have seen an important number of laparoscopic and endoscopic approaches to inguinal hernia. A TAPP (transabdominal pre-peritoneal) technique described in 1993 is based on the same principle as the technique published by Lawson Tait in 1891. Tait described a transabdominal approach to inguinal hernia performed simultaneously with other interventions requiring a laparotomy [24]. In TAPP the same rationale is used in laparoscopy and an artificial mesh is placed in preperitoneal position after incising the peritoneum [25]. Another endoscopic procedure is TEP (totally extraperitoneal) in which an endoscope is introduced into Retzius and Bogros space after creating a space for gas insufflation with a specially designed balloon [26]. Afterwards, a mesh is placed in preperitoneal space and the operation is concluded. And finally an IPOM (intraperitoneal onlay mesh) is a laparoscopic technique developed in 1991 and consisting on placing a polytetrafluorethylene mesh directly on the defect from peritoneal side and securing it with a double crown of staplers [27].

After initial enthusiasm for the endoscopic hernia repairs it became clear that although these techniques have some important advantages for patients in no way can they be considered the ideal operation for every patient. Today, endoscopic techniques, while still popular in some centers, coexist peacefully with traditional open techniques of hernia repair. In a review of inguinal hernia repairs performed in USA until 2003 the most commonly used techniques were: Lichtenstein repair (350.000/year), Rutkow-Robins repair (200.000/year), endoscopic repairs (75.000/year), Bassini repair (50.000/year), McVay (less than 50.000/year) and Shouldice repair (less than 50.000/year) [28]. The use of endoscopic techniques is commonly accepted for the treatment of recurrent and bilateral hernias. As seen in the numbers cited above, when facing a non-complicated primary inguinal hernia the vast majority of today's surgeons choose tension-free repairs as described by Lichtenstein and Rutkow [29].

6. Conclusion

The surgical treatment of inguinal hernia has made important steps forward during the last 125 years. However, the fact that we still employ a wide variety of techniques to operate on inguinal hernia clearly shows that the road to a perfect operation is still ahead of us.

Acknowledgements

The author wish to thank dr Jerzy W.Mituś from Kraków, Poland for the preparation of the Figures 4, 5, 6 and 7.

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