



## Inguinal Hernia: Modern Aspects of Etiopathogenesis and Treatment

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**Abstract:** The article presents modern data on the surgical treatment of inguinal hernias, describes the most common methods of alloplasty, their advantages and disadvantages, presents the experience of domestic and foreign researchers. During the search, it was found that in the methods used for the treatment of inguinal hernias over the past 10-15 years, a consistent evolution has been noted. The main change is that a mesh is used to close the posterior wall of the inguinal canal, and the principle of tissue tension-free treatment is introduced. One of the methods using these new principles is laparoscopic hernioplasty, introduced into practice in the early 90s of the last century. Summing up, it can be noted that, with all the numerous publications, there is no single tactical doctrine when choosing a method of treating inguinal hernias, the opinions of various authors about the advantages and disadvantages of modern methods of eliminating inguinal hernias are contradictory, this was an incentive for doing this work.

**Keywords:** inguinal hernia, surgical treatment, alloplasty, mesh endoprosthesis, relapse.

### Essays on the development of the doctrine of inguinal hernias.

Before considering the current state of herniology, it is necessary to briefly trace the history of the theory of hernias and note the most significant provisions that largely determined this state.

In 1891, a professor at King's College from Birmingham, Lawson Tait, noted: "An operation for an inguinal hernia should be performed not only without complications, but it should be simplified to the limit" and proposed to operate on an inguinal hernia from the abdominal cavity. L. Tait made a glutomy along the midline between the navel and the pubis, entered the abdominal cavity with his hand and examined the hernia. If there were adhesions of the viscera with the hernial sac, the author exposed the sac with an additional incision in the groin region and highlighted the viscera. After repositioning the latter, he sutured the abdominal inguinal opening from the abdominal cavity, controlling the suturing with a finger of the other hand from the side of the skin. Then the author made a conclusion: "Correct and really radical surgical treatment of hernia should be performed from the inside using laparotomy" [23].

In 1899 prof. Assaky also suggested suturing the hernial orifice from the side of the abdominal cavity, and he recommended his method especially for the elderly and for patients with flaccid, atrophic muscles [66]. Later in 1932 G. La Rock proposed an "intra-abdominal method" of hernioplasty, in which the access to the hernial orifice was carried out through the abdominal cavity after an incision above the inguinal fold. At the same time, the hernial sac was excised from the side of the abdominal cavity, and the hernial orifice was sutured. The author noted the following advantages of this technique: more accurate diagnosis of hernia (straight, oblique, combined, sliding, restrained); more convenient excision of the hernial sac without damaging the spermatic cord. The

main advantage of the method G. La Rock considered the usefulness of diagnosis, radicality and safety of resection of areas of organ necrosis in strangulated hernias [12, 28].

But intraperitoneal methods of treating inguinal hernias have not found supporters for almost 100 years. Most researchers tried to improve the Bassini operation, which for many years remained the "gold standard" in the treatment of inguinal hernias. Bassini E. (1894) in Europe (Italy) and Halsted W. (1889) in the USA proposed a hernioplasty method aimed at strengthening the posterior wall of the inguinal canal [26, 40]. For a long time, almost until the 70s of the twentieth century, this operation, especially in the United States, was the "gold standard" in the treatment of inguinal hernias. In Europe and Russia, preference for oblique hernias was given to methods of strengthening the anterior wall of the inguinal canal [15, 24, 45], and only with direct and complex hernias, the posterior wall was strengthened [2, 29, 47].

A wide variety of extraperitoneal methods for an inguinal hernia operation depends on the many modifications that are proposed for various stages of hernioplasty: when processing a hernial sac, when closing a hernial gate, when moving the spermatic cord, and, finally, a method of suturing or plastics of the walls of the inguinal canal. Therefore, extraperitoneal hernia repair methods can be divided into 6 groups: 1) methods, where the main part of the operation is the processing of the hernial sac, 2) methods of narrowing the inguinal canal without opening it, 3) methods of restoring a normal inguinal canal, 4) methods of forming a new inguinal canal, 5) plastic methods of closing the hernia orifice, 6) methods without immersion seams.

All methods of processing the hernial sac can be divided into 3 groups: 1) the hernial sac is carefully selected, tied as high as possible and cut off, 2) the hernial sac, isolated in full length, is disposed of for one purpose or another, 3) the hernial sac remains without isolation for place, being bandaged only in the neck area [3, 17, 26].

In the 70s of the twentieth century, thanks to good long-term results, in the United States, the McVay C. (1948) and Shouldice E. (1945) operations became the "gold standard" - the recurrence of hernia during these operations was less than 1%, although it should be noted that these results were obtained in the hands of the authors themselves [15, 47]. With widespread use, the relapse rate reached 15.5% [30].

Dissatisfaction with the results of hernia repair has long prompted surgeons to use transplantation of various tissues and materials in the process of hernioplasty, especially for large defects. The search for the best materials has been in progress for over 130 years.

In case of inguinal hernias, various types of autografts have been proposed to strengthen the walls of the inguinal canal. For example, they used: fascia in the form of a free graft (1909, M. Kirschner), leg flaps (1934, A. Wahgensteen), fascial sutures (1901, L. McArtur), periosteum and oblique-periosteal flaps from the tibia and pubic bone patient (1922, M. Kirschner, A.P. Krymov, N. Baker), de-epithelized skin (1914, E. Rehn), rectus abdominis flap (1893, F. Schwartz), tailor muscle (1896, J. DeGaray). Currently, most of these methods have been abandoned and only autodermoplasty is used [12, 44].

Homo- and heterografts were also used: transplantation of a bone plate from other patients (1890, F. Trendelenburg) or animals (1890, N. Weyr), preserved cadaveric fascia (1948, I.S. Kogan), taken from animals of the peritoneum (1957, P.P. Khokhlov) and dura mater (1920, A. Taylor). Currently, this method is used by a few authors [34].

In 1889 Witzel used a silver mesh, in 1900 Busse used plates of gold, copper and various alloys (Dural, Electron) and obtained poor results due to the rigidity and weight of the material. Rubber pads (1913, Fieschi) and flaps (1914, Delbet) caused such serious complications that they were quickly abandoned. Metal meshes made of stainless steel and titanium were often used in the 40s of the 20th century. However, in the 50s, they were abandoned due to the discomfort caused by rigidity and the tendency to migrate and rapidly defragment the implant.

After World War II, advances in the chemical industry made it possible to use various polymeric materials in surgery. Thus, in Europe, Don Acquaviva was the first to use nylon to treat hernias in

1948, Wolstenholme used dacron (lavsan) in 1956, and in the USA Koontz used polypropylene in 1959 [47].

Many different polymeric materials are currently used to treat hernias. According to their chemical structure, all currently used materials can be divided into four groups. Non-absorbable - 1) polypropylene; 2) polyester (lavsan); 3) polytetrafluoroethylene. Absorbable - 4) polyglactin (polyglycolic). Each of these materials has its own advantages and disadvantages [37]. For more than 100 years of history of use, many researchers have established requirements for an “ideal” prosthetic material: resistance, flexibility, ease of penetration by connective tissue, resistance to infection, strength after incorporation into tissues, X-ray negativity, ease of sterilization and low cost. None of the existing prostheses fully meets all these requirements. Currently, research is aimed at creating composite materials in order to combine, enhance positive properties and neutralize negative ones [17, 26, 41].

Based on the physical characteristics described above, Amid proposed a classification of synthetic materials in 1997 [4]. Its classification is based on pore size and fiber type. He divided all materials into 4 types. The 1st type includes meshes with pore sizes exceeding 75 microns. Type 2 consisted of monofilament fiber meshes with a pore size of less than 10 microns. By the 3rd type includes a grid of polyfilament fibers with a pore size greater than 75 microns. And, finally, the 4th type was made up of meshes, the pore size of which is so small that it cannot be determined instrumentally. This classification of materials has become widely known and has been repeatedly quoted in various monographs. However, it should be noted that to date, this classification is somewhat outdated, so manufacturers began to produce new mesh prostheses that do not fall into the classification by Amid. Thus, Cardoso offers a classification in which mesh prostheses are divided into 6 types [6]. The first 3 types correspond to the Amid classification, with the only difference that the 1st type is subdivided into lightweight materials (density less than 5 mg / cm<sup>2</sup>) and heavy (density more than 5 mg / cm<sup>2</sup>). Type 4 includes composite meshes, such as meshes that contain absorbable and non-absorbable fibers. The 5th type includes meshes obtained by fusion welding ("Bonded mesh"). The pore size of such networks does not exceed 10 microns. And finally, the 6th type corresponds to the 4th type of the Amid classification... The similarity of these classifications suggests that today it is difficult to propose any other criteria that would allow dividing existing synthetic prostheses into groups. However, the manufacturing process of the meshes is becoming more complex and it is possible that pore size and fiber characteristics will not only be of key importance in the near future. After all, it has already become clear that the advantage of type 1 nets over other types is undeniable. This means that it is necessary to develop technological evolution in the direction of improving this type of mesh. Polypropylene Describing the history of the use of synthetic materials in medicine, we have already mentioned polypropylene. Therefore, we briefly summarize the previously indicated information. So polypropylene was first synthesized in 1954 by Rehn and Natta [26]. To do this, they used a titanium-based catalyst now known as the classic Ziegler - Natta catalyst. The monomer unit is propylene (propene). Propylene is an unsaturated hydrocarbon, combustible gas. Propylene is isolated from refinery gases or associated gases, as well as from coal coking gases. Usher first used polypropylene mesh in 1960. Two years later, the now well-known company "Ethicon Ltd" launches a polypropylene mesh called "Marlex" on the market. 27 years later Lichtenstein will publish his work on the use of polypropylene meshes in the treatment of hernias, making it the standard in their treatment. In this regard, it is necessary to dwell on the safety issues of the use of polypropylene in humans. Polypropylene in its pure form is non-toxic and does not cause any response from the body. However, numerous additional chemical compounds that are added to polypropylene during the production of the finished product cause possible side reactions [18]. A complete list of what is included in the prolene known only to the manufacturer. But even the part that is known to the general public is impressive. So, plasticizers, antioxidants, stabilizers, acid neutralizers, neutralizers of free radicals, antistatic agents, dyes, substances that counteract adhesion and friction, structuring agents are added to polypropylene [21].

Thus, the history of herniology developed along the following lines:

1. search for simple, safe, reliable methods of surgical treatment of inguinal hernias;

2. search for minimally traumatic access to the hernial orifice without opening the inguinal canal;
3. replacement of degeneratively altered tissues with a suitable alloplastic material.

### **The incidence of inguinal hernias in general surgical pathology and the reasons for dissatisfaction with the results of their surgical treatment.**

Inguinal hernias occupy an important place in the structure of the surgical morbidity of the population. This pathology occurs in 1-2.5% of men and 0.3-1.5% of women, accounting for up to 80% of all types of abdominal hernias [14, 19, 27]. In Russia, up to 600,000 operations are performed per year [1, 15, 46], in England more than 80,000, in the USA almost 1,000,000., In Europe about 1,000,000 [25, 34, 42]. Moreover, the frequency of hernias over the years does not change significantly in different countries [15, 27].

Back in 1969 N.I. Kukudzhanov pointed out: “Inguinal hernia is one of the most common surgical diseases. From 4 to 6% or more of all operations in surgical departments are performed for inguinal hernias. This disease leads to a significant decrease in human performance, and often to severe complications” [24].

In itself, the presence of an uncomplicated hernia significantly disrupts the general condition, quality of life and reduces the ability of patients to work [8, 15]. However, according to many surgeons and healthcare organizers, the urgent need to eliminate hernia in a planned manner is dictated, first of all, by a possible formidable complication of this disease - infringement. The frequency of this complication is high, and the results of treatment are unsatisfactory due to the high mortality rate - from 4.3% to 10%. This situation has been maintained over the past 50 years [8, 13, 28, 40].

Undoubtedly, the timely planned elimination of the hernia by surgery is the most rational measure for the prevention of its complications. In 1965 T.E. Gnilorybov and Yu.K. Turner presented convincing comparative data on the results of clinical examination of hernia carriers in Minsk - a decrease in hernia repair for incarcerated hernias from 21.7% to 6.6% made it possible to reduce the overall postoperative mortality rate from 0.6% to 0 [8]. According to the Moscow Bureau of Medical Statistics, the ratio of planned and emergency hernia operations is 3:1. In most developed countries, this ratio is on average 10:1 [9].

Surgical intervention is currently the only method of treating inguinal hernias [28]. According to some statistical data, surgery for an uncomplicated inguinal hernia, at present, can be considered a relatively safe intervention, according to others, the number of complications (hematomas, seromas, neuralgia, vascular damage, impaired spermatogenesis, etc.) is quite large [1,15].

The results of traditional surgical treatment of inguinal hernias, despite the many proposed methods of hernioplasty, are recognized as unsatisfactory due to the high recurrence rate, which is 10% for simple hernias and up to 30% for large and recurrent hernias [3, 31, 38].

Considering the above frequency of inguinal hernia repair, it is not difficult to realize that every percentage of recurrence means thousands of patients suffering from failed hernia repairs. Since E. Bassini practically started the modern era of inguinal hernia surgery in the 1980s [47], the recurrence rate in simple hernias has remained at a constant level of about 10%. Only in some centers specializing in the treatment of hernias, acceptable results were obtained - less than 1% of recurrences [40, 45].

The causes of relapses are diverse, and the role of each of them is different. So, some authors give the first place to the inexperience of the surgeon and technical errors [8, 19, 22], others - the pathogenetic unfoundedness of the method of hernioplasty, third authors note that relapses are also due to the inexperience of the surgeon, and pathogenetic failure of the operation [12, 17, 26]. The causes of recurrence with a traditional anterior approach are: tissue tension [17, 19, 42]; missed or unnoticed hernial orifices [2, 17, 23]; the inherent weakness of collagen tissue [22]; and technical errors [6, 15, 32]. At the beginning of the last century (1900), at the 1st Congress of Russian Surgeons, one of the classics of Russian herniology A.A. Bobrov argued: “there are hernias that can



be cured by any surgical method, and, conversely, there are hernias that recur regardless of the method of surgery” [4].

The dissatisfaction of surgeons with the results of treatment of inguinal hernias with traditional methods leads to the search for new methods and approaches. Some authors follow the path of developing "new" techniques and improving traditional operations [3, 10, 19], others use new technologies and materials. A significant number of researchers see the prospects for successful treatment of inguinal hernias in an individual, differentiated approach to the choice of the method of surgery [13, 19, 26].

So, some surgeons with simple hernias are limited to high ligation of the hernial sac and strengthening the anterior wall of the inguinal canal. For complex ones, the back wall is strengthened, and for large and recurrent hernias, a complete restructuring of the inguinal canal using alloplastic is considered necessary. This approach to the treatment of inguinal hernia reduces recurrence to 0.6-2.5% [1, 19, 25, 41]. Other authors insist on the mandatory strengthening of the posterior wall of the inguinal canal for any type, shape and size of hernia. And with this approach, the relapse is reduced to 0.6-2.5% [16, 24, 37]. However, it should be noted that such a decrease in the level of hernia recurrence is characteristic of the individual statistics of the authors. Large, generalizing studies at the national and international level indicate a recurrence rate of up to 10%, and with simple and up to 30% complex and recurrent hernias [3, 12, 27].

Unsuccessful primary hernia repair leads to a perversion of topographic relationships and an increase in the defect of worn out, atrophied and degenerated muscle and aponeurotic tissues - all this significantly complicates the conditions and complicates the technique of repeated hernia repair. To this it should be added that unsuccessful primary intervention reduces the regenerative capacity of tissues [15].

The result of hernia repair, not to mention the complications possible during any operation (hematoma, suppuration, etc.), may depend on two kinds of factors: on the individual characteristics of the patient and on the characteristics of the surgical intervention [24]. The most controversial issue is the choice of the method of operation. The most serious reasons for choosing a rational method of hernia repair are, on the one hand, statistical data on the results of using various methods and, on the other hand, pathogenetic considerations depending on the type of hernia. Considerations, sometimes interpreted in different ways [15, 21].

Over the past 20 years, interest has revived in the development of new approaches to the treatment of inguinal hernias. In 1979, the European Hernia Society (EHS-GREPA) was created in France, which annually holds international congresses on herniology. In 1997, a similar society was created in the USA - the American Hernial Society (AHS). Since 1997, both societies have been publishing the magazine “Hernia”, which is published 4 times a year. All this could not but cause a boom in new approaches to the treatment of inguinal hernias.

This is due to several factors [16]:

1. development of new surgical technologies;
2. pressure from employers, insurance companies and patients to reduce the gross cost of medicine;
3. dissatisfaction of surgeons and patients with the results of treatment of inguinal hernias.

### **Modern methods of surgical treatment of inguinal hernias.**

To date, more than 600 methods have been proposed for the treatment of inguinal hernias; every year, only in our country, surgeons offer 5-10 new methods and modifications of hernioplasty. To understand this variety of operations, a classification is required that would reflect the entire variety of interventions, highlight fundamental differences and would not be cumbersome.

For these reasons, the classification of surgical interventions proposed by A.P. Krymov in 1929 and N.I. Kukudzhyanov in 1969, are of little use for practical use due to the bulkiness and lack of modern " tension-free " methods of hernioplasty [22, 24].

A.I. Mariev and N. D. Ushakov in the monograph "External abdominal hernias" (1998) divide all operations only by access: inguinal, preperitoneal and intraperitoneal [28]. In addition, the authors distinguish separately endoscopic hernioplasty, which is methodologically incorrect.

B.N. Egiev et al. [32] combine all types of hernioplasty into several groups: "anterior tension" methods, "posterior tension" methods (intraperitoneal and extraperitoneal), combined (various combinations of the above methods), auto - and alloplastic methods, laparoscopic plastic. This classification also suffers from methodological drawbacks, since the anterior approaches, both "tension" and "non-tension", can be extraperitoneal and intraperitoneal, and alloplasty can be performed from the anterior and posterior approaches.

The most successful, in our opinion, modern classification of operations for inguinal hernias was proposed by R. Stoppa et al. In 1998 [28] and looks like this:

Classification of operations for inguinal hernia (R. Stoppa, 1998)

A. Access:

- front;
- transabdominal;
- preperitoneal;
- endoscopic - transabdominal (TAPP);
- completely extraperitoneal (TEP).

B. Reconstruction of the inguinal canal:

- plastics with local tissues;
- alloplasty.

A pre-peritoneal approach for treating inguinal hernias using a mesh implant is being promoted by several surgeons.

L.M. Nyhus et al. Place the cut mesh after the preperitoneal repair of the hernial defect. The prosthesis is placed in the form of a cloak and sutured to the Cooper's ligament and transverse fascia [16, 27].

Rignault's technique is different: through the Pfannenstiel access, the hernia is first eliminated by simple suturing, then a 10x12 cm piece of prosthetic material is inserted into the preperitoneal space. The spermatic cord is passed through a special cut in the mesh (keyhole defect). Rignault notes that the polyester material (Dacron) is especially good for this operation because of its flexibility and good connective tissue growth. Sutures for mesh fixation, according to the author, are not needed [12].

The technique used by Stoppa et al. Is similar to that of Rignault, but these authors do not repair the defect itself. They insert a 15x15 cm piece of mesh and fix it to the posterior wall of the inguinal canal along the periphery. The mesh is either cut to hold the cord, or simply placed over the cord and the inner opening of the inguinal canal [26, 35, 42].

These three groups of authors note a small percentage of relapses of 1.4-2.2%, but they argue that the treatment of recurrent relapses after such operations is very difficult and sometimes dramatic [44].

In Russia, the pre-peritoneal method of allohernioplasty is widely used in the clinic of the faculty of surgery of the St. Petersburg Medical University [46].

In 1966, the director of the Hernia Institute (Los Angeles; USA) IL Lichtenstein focuses the attention of his surgeons on the importance of reducing pain after surgery, shortening the rehabilitation period and reducing the rate of relapse [48]. As a result, after almost 20 years of research work, the Lichtenstein Hernia Institute employees developed the concept of "Tension-free" hernioplasty, which is based on two postulates: a) initial tissue degeneration in an inguinal hernia, b) excessive tissue tension along the suture line with traditional hernioplasty [20]. In June 1984, the institute began a

widespread performance of hernioplasty, which is known as the Liechtenstein operation. In 1996, the authors published the results of using this method in 4000 patients who underwent 5000 hernioplasty, 99% of patients were discharged from the clinic after 2-3 hours. Relapses occurred in 4 patients (0.1%), and in 3 patients operated on in the early period of the study (the so-called period of mastering the technique) [18].

The methods used for the treatment of inguinal hernias have been consistently evolving over the past 10-15 years. The main change is that a mesh is used to close the posterior wall of the inguinal canal, and the principle of tissue tension-free treatment is introduced. One of the methods using these new principles is laparoscopic hernioplasty, introduced into practice in the early 90s of the last centuries.

### **The role of video endo-surgery in the treatment of inguinal hernias.**

In 1982, R. Ger described the treatment of various inguinal hernias through a trans-abdominal approach in patients who underwent laparotomy for another intra-abdominal pathology [15]. He found that a hernia can be effectively repaired by simply suturing the hernial orifice from the inside without dissection, alloying, and excision of the hernial sac. Michel clips of stainless steel (3×15mm) were applied with a Kocher clipper inserted through the laparotomy wound. Only one relapse was noted in a series of 13 patients (7.7%), the follow-up period was 44 months. The last patient in this group underwent suturing of the hernial defect by applying staples under a laparoscopic view. Staples were applied with a special apparatus “Herniostat” inserted through a laparoscopic cannula. This tool became the prototype of various herniostepplers developed later. The patient was followed up for 8 years without signs of relapse. Thus, Robert Ger is recognized as the surgeon who performed the world's first laparoscopic hernioplasty. In further, including in experimental work, R. Ger established the main advantages of laparoscopic treatment of inguinal hernias [13, 18, 33]:

- Small section;
- Reducing the chance of damage to the spermatic cord and testicle;
- Exclusion of ilio-inguinal postoperative neuralgia;
- Ability to achieve the highest possible closure of the peritoneal sac;
- Minimal postoperative discomfort;
- Ability to diagnose and treat bilateral inguinal hernias without wide dissection.

In addition to the advantages, the author himself notes the disadvantages of the method: with deep insertion, the staples cut through the peritoneum and become invisible, and with superficial insertion of staples, the gate closure is unreliable, which leads to an inevitable relapse. Therefore, at present, this method of treating inguinal hernias is not recommended for use [13, 29, 30].

In 1989, S. Bogojavalensky showed the first video on laparoscopic hernioplasty for inguinal and femoral hernias. In this case, the peritoneum was opened under an endoscopic view, a blunt dissection of the muscle-fascial defect was performed, after which the defect was filled with a rolled proline mesh [26].

In early 1990, L.W. Popp reported the endoscopic closure of a straight inguinal hernia in a woman by endoscopic suturing the inner inguinal ring followed by intraperitoneal fixation of the dura mater flap using endo-suture catguts with extracorporeal knot tying [18].

LS Schultz et al. published the first observations of laparoscopic hernioplasty in 1990. These researchers, after opening the peritoneum over the hernial orifice with an oblique hernia, introduced a rolled mesh roll into the hernial defect, after which they closed the gate with a small piece of mesh, which was fixed with clips. Then the peritoneum above the mesh was sutured with staples or an endo suture. Several early recurrences were due to an unrecognized concomitant direct hernia [22]. This forced the authors to adapt the technique, which included a wider groin dissection and the use of a wider mesh after root canal filling to cover both the lateral and medial inguinal fossa. After that, the results of the operation became satisfactory [44].

Initially, the incidence of relapses and complications in laparoscopic hernioplasty was high - up to 25% [25], but over the past 5 years, many centers with extensive experience in laparoscopic hernioplasty have reported results with a relapse rate of less than 1% [16, 28, 43], and with a frequency complication - less than with open surgery [15, 32]. At the same time, it is noted that repeated operations are difficult, regardless of whether an experienced or inexperienced surgeon performed the first operation [22].

In May 1991, surgeons from Indianapolis (USA) M. Arregui and R. Nagan described the technique of laparoscopic hernioplasty, which included: opening the peritoneum, thorough dissection of the posterior wall of the groin region, preperitoneal placement of a mesh implant with covering of all "weak" spots, fixing the mesh along perimeter with staples, suturing of the peritoneum over the mesh (peritonization) [33]. This technique is called laparoscopic trans abdominal preperitoneal hernioplasty (TAPP) and has become one of the most popular in the world. Currently, foreign national statisticians analyze the results of more than 10,000 operations performed using this method [14, 29]. In Russia, some clinics have experience of more than 2000 such operations [8, 18, 39].

In June 1990, in the laboratory of experimental laparoscopic surgery in the USA, R. Fitzgibbons and C. Filipi began research on pigs on the use of intraperitoneal mesh implant placement to cover the hernial orifice without opening the peritoneum. A polypropylene implant was used. The study showed that with the laparotomic placement of the mesh and its fixation in 100% of the animals, a powerful adhesion process with the involvement of the omentum and loops of the small intestine was noted, and with the laparoscopic one, a moderately pronounced adhesion process was noted in 15% of the animals, and mainly the bladder was soldered to the mesh and less often the small intestine. Based on the results of the study, it was decided to use this technique in the treatment of inguinal hernias in humans. The technique was named "Intraperitoneal on lay mesh technique"- IPOM [32]. This operation has greatly simplified laparoscopic hernioplasty. However, significant shortcomings were quickly identified: fragile fixation led to the migration of the prosthesis and inevitable relapse, the adhesion process caused such serious complications as acute adhesive small bowel obstruction, pressure ulcers of the bowel and bladder with the development of fistulas [30, 33]. Attempts to use other plastic materials turned out to be untenable [5, 19], and at present this technique is not used.

To exclude possible complications associated with the introduction of instruments into the abdominal cavity and manipulations in it, in 1991 J. Dulucq (France) proposed a completely preperitoneal hernioplasty using laparoscopic instruments (TEP - total extraperitoneal). In the USA, Mc Kernan [40] was the first promoter of this method. The method consists in creating a pre-abdominal space by blunt dissection, gas, or liquid in a special balloon, which is carried out from the navel to the groin area. Then the operation is carried out in the same way as in the TAPP method (setting the mesh and fixing it). In theory, TEP eliminates the risk of intra-abdominal injury and adhesion formation. However, the method is time consuming as the work space is small and orientation can be difficult. Surgeons cannot begin this operation until they have mastered TAPP - an operation in order to freely navigate the anatomy of the pre-abdominal space of the groin area. Unexpected peritoneal perforation is highly likely, especially in patients with previous lower abdominal surgery. Moreover, the perforation can go unnoticed, which leads to contact of the implant with the abdominal organs. Nevertheless, hernioplasty is performed entirely by the extraperitoneal approach [45].

Over the past 10 years, a lot of works have appeared, according to a comparative assessment, of various methods of surgical treatment of inguinal hernias. Comparisons are made between traditional methods based on plastic with local tissues (in Russia, these are the operations of Spasokukotsky, Kukudzhinov, Martynov, Postemsky and their modifications; in the USA and Europe - operations Bassini, MacVay, Shouldice) and methods based on the use of prosthetic materials (operations Lichtenstein 'a, Stoppa, endoscopic: TAPP and TEP) [6,13, 34].

However, in most of the listed works, the comparison of the results was carried out methodologically incorrectly. Firstly: not homogeneous groups of patients are compared [13, 21, 34], secondly: the experience and qualifications of surgeons are not considered, and, most importantly, groups of patients are formed according to the approach (endoscopic and traditional, the so-called "open"), and the conclusions follow about the allegedly different methods of hernioplasty. Therefore, more



reliable and interesting works where "tension" and "non-tension" methods of hernioplasty are compared, and laparoscopic hernioplasty, as one of the "non-tension" methods, is compared with the Liechtenstein operation [6, 21, 34, 45].

Since the world experience in performing endoscopic operations to eliminate inguinal hernias is tens of thousands of operations, and the duration of observation of these patients exceeds 10-12 years, there have been works on the study of long-term results [17, 38]. According to some authors, identifying the reasons for the failure of the primary endoscopic treatment of inguinal hernias allows us to modernize the technique and significantly improve the results of the operation [20, 42, 48].

The main causes of hernia recurrence after laparoscopic hernioplasty have been identified [22, 26]:

- inexperience of the surgeon;
- incomplete dissection of the pre-peritoneal space - small size of the implant - inadequate mesh fixation.

Since laparoscopic hernia repair virtually eliminates missed tension hernia and tissue degenerative changes, which are the main causes of relapse with open operations, technical errors remain the most important cause of relapse after a laparoscopic hernia repair. The number of these errors decreases with experience [14, 26].

Experience reduces the number of technical errors such as missed hernias, mesh too small, and inadequate tissue dissection. Abandoned lipomas and mesh migration remain the most common causes of recurrence in the hands of experienced surgeons [12]. Lipomas remain due to the fact that the surgeon either examines them, or when removed from the canal, the lipoma ruptures and part of it remains in the canal. Migration of the mesh or folding of its edges occurs either due to inadequate fixation along the medial edge, or due to the impossibility of fixation along the lateral edge, since nerve trunks pass there. The incision of the mesh to bring it under the spermatic cord reduces lateral incompetence, but this increases the chance of recurrence of hernia through the mesh and pain may occur along the cord [33, 40].

In general, most authors note that complications in laparoscopic hernioplasty are much less common than in traditional surgery [26, 32]. However, some surgeons consider that complications after laparoscopic hernia repair are more severe [30]. Complications such as acute intestinal obstruction [15, 19], urinary fistulas and stones due to pressure ulcers of the implant [12], damage to hollow organs and large vessels [46], severe neuralgia [30, 36], testicular atrophy [28] have been described.

Thus, it is possible to identify certain trends in modern herniology:

1. main method of treatment of inguinal hernias is Liechtenstein's operation.
2. best results were obtained in specialized herniocenters.
3. Laparoscopic hernia repair can be an alternative to traditional methods
4. Treatment of inguinal hernias only in specialized laparoscopic centers, subject to a significant reduction in the cost of the operation.

It should be noted that, despite the large number of publications, there is no single tactical doctrine when choosing a method for treating inguinal hernias, the opinions of various authors about the advantages and disadvantages of modern methods of eliminating inguinal hernias are contradictory, this was an incentive for doing this work.

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