THE INTRAPERITONEAL TENSION-FREE PLASTY OF ABDOMINAL WALL WITH MESH USE — CURRENT STATE OF PROBLEM

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Tension-free plasty with synthetic mesh use is the method of choice in modern surgery of abdominal wall hernias. In the review the basics variants of mesh implantation with its benefits and drawbacks are presented. The advantages and disadvantages of Lichtenstein, TAPP, TEP, and IPOM techniques are shown. The benefits and drawbacks of intraperitoneal onlay mesh technique (IPOM) are given in detail. Standard tension-free procedures in surgery of inguinal hernias are described. The important steps in prosthetic repair of medial defects in abdominal wall are estimated.

There are considered the features and results of applying sublay, inlay and onlay procedures. The possibilities of preperitoneal, intraabdominal, and retromuscular placement of synthetic endoprostheses are discussed. Adverse sequela of plasty, and its suspected pathogenetic mechanisms are considered. The ways in prophylaxis of complications are shown: mesh isolation, anti-adhesive covering, sutureless and glue fixation of endoprosthesis, development of new synthetic materials. Based on the analysis of literature reports we have concluded that the danger of intraabdominal complications after IPOM is exaggerated. Tension-free intraperitoneal plasty with synthetic endoprostheses in abdominal wall hernias is a simple and reliable surgical approach.

Key words: abdominal hernia; tension-free plasty; intraperitoneal plasty; mesh endoprostheses; IPOM.

The problem of abdominal wall repair is unsolved till now [1, 2]. The collagenopathy and changes of abdominal wall function are in basis of hernia formation [3, 4]. Over hundreds of surgical procedures, synthetic materials and methods of their implantation have been offered so far, however we have no ideal solution [2, 4, 5]. The tension-free plasty with synthetic mesh ranks first in hernia repair that has significantly improved the results and reduced the recurrence rate [6, 7]. The use of mesh is recommended both in scheduled surgery, and in emergency [8–13]. The implantation of synthetic endoprosthesis is considered possible and useful in some cases of peritonitis and eventration [14, 15]. This approach is proved pathogenically, because the tension-free technique is helpful in solving the problem of abdominal compartment syndrome [16, 17]. This type of surgery is recommended as a method of choice in strangulated hernia repair, which significantly reduces the incidence of complications and mortality [18]. Long-term results are generally assessed by analysis of quality of life indicator [19, 20]. In this regard the advantages of tension-free technique are proved [21].

However, as far as experience in abdominal wall plasty with mesh use has been gained, the delight in the results of the first operations has gone. New problems have arisen, and surgeons discuss them not as enthusiastically as before [22–24]. The implantation of mesh was found to give no assurances of recurrence absence [25]. There are experimental data on male infertility after mesh inguinal plasty were received [26]. Clinical results are different, but some studies confirm grave reservations concerning the problem [27].

The mesh-associated chronic pain, foreign body sensation and stiff-man syndrome were described [28, 29]. The data on testicular atrophy and ejaculatory dysfunction were published [30]. Mesh shrinkage effect (4–50%) that results in recurrence has not been corrected so far [31, 32]. The impact of mesh material and its fixation method on a phenomenon of shrinkage and dislocation is not clear and actively studied currently [33]. It is proved that the morphological patterns of reparative process are common for many types of operations and materials [34]. The reparative process includes aseptic inflammation after mesh implantation, angiogenesis, connective tissue formation (first — young tissue, and then — mature) [34]. However, in some cases the inflammation after reparative process termination persists [2]. It is not improbable that chronic inflammatory in implantation zone forms the basis of most problems [24]. Probably, this is precisely why chronic pain syndrome and foreign body sensation are observed after both open repair, and endoscopic surgery [29]. The results of treatment depend on clinical experience, endoprosthesis used, type of plasty chosen, as well as appropriate

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complication prevention [35]. The impact of mesh material or operative method on life quality indicators are the subject of close attention of physicians [21, 36].

Let us consider the basic modern techniques of mesh use in inguinal hernia repair. Lichtenstein plasty is thought to be the best, as its application is associated with very low relapse rate [7]. The technique provides a typical approach to the inguinal canal, and a prosthetic repair of its posterior wall. In this case a funiculus spermaticus passes through a hole in a mesh and is located distally between endoprosthesis and aponeurosis of abdominal external oblique muscle [7, 37]. The most steps of this operation are well known for all surgeons using autoplasty for inguinal hernia repair. This operation can be performed as an outpatient procedure. The weakness of Lichtenstein repair is the contact between spermatic cord and mesh for a considerable distance. After mesh implantation in the inguinal canal, the paraprosthetic granulomas form, a funicle is fused with a mesh, the lumen of ductus deferens is obstructed [38]. These phenomena lead to the development of obstructive azoospermia [26]. The same morphological changes are in the basis of neuropathy of n. inguinalis and chronic pain syndrome. To date there is still no endoprosthesis without the property indicated. The most common material in hernia repair is polypropylene. The local inflammatory reaction is known to be characteristic of a reparative process after polypropylene mesh implantation [39], and the basis for a number of complications in the postoperative period, their frequency being 2–33% [23, 40, 41]. However, Lichtenstein method is the most reliable, easy to learn technique, the use of which provides a good quality of life [40, 41, 42].

The alternative variants of tension-free inguinal hernia repair are endoscopic procedures TAPP (transabdominal preperitoneal) and TEP (total extraperitoneal) [37, 43]. The first procedure includes laparoscopic approach, dissection of peritoneum in the area of hernia orifices, tissues dissection and preperitoneal mesh implantation. The drawback of TAPP is the need for contact with the abdominal cavity, a relative complexity. The result of operation does not exclude the development of abdominal adhesions and the formation of trocar hernias. The surgeon requires impeccable knowledge of anatomy, problem areas, in which the technique should be especially careful and mesh fixation is dangerous («fatal triangle», «triangle of pain») [7, 42, 43].

TEP involves placing a mesh into preperitoneal space without opening the abdominal cavity. The technique is extremely time-consuming and requires a long training, first — TAPP, and only then — TEP [7, 37, 42]. The contact between ductus deferens and synthetic material is significant in both operations (TAPP and TEP). Compared to Lichtenstein method, the use of TEP is associated with higher complication rates, the long duration of the intervention, its high cost, but the earlier activation of patients and less time disability. [40] Late results and life quality data after TEP, TAPP and Lichtenstein procedures are generally comparable [40, 44].

IPOM (intraperitoneal onlay mesh) is a tension-free method of abdominal wall repair, which includes an access to the abdominal cavity (endoscopic or open), intraperitoneal mesh placement with complete overlap of the existing defect [45]. The simplicity of the first stage performance, reliability and easy learning to use the technique is the characteristic of IPOM [46, 47]. Recent studies clearly demonstrated that the use of this method is associated with lower pain syndrome than TAPP and required minimal operation time [48]. There is no contact between an implant and spermatic cord that gives hope for a positive result regarding fertility. The downside of IPOM is the risk of adhesions formation in the abdominal cavity and other intraabdominal complications [49]. However, on the other hand, such problems are nonspecific and also found in other techniques of the inguinal canal reconstruction [50, 51]. Wider adoption of IPOM became possible after the development of composite implants with anti-adhesive properties of their visceral surface [52–54]. The use of special fixation methods (sutureless technique, the use of glue) significantly expanded the possibilities of this technology [54].

In the surgical treatment of incisional ventral, umbilical hernias there widely used onlay, sublay and inlay techniques. Onlay technique involves mesh implantation over the defect of abdominal wall [55]. This operation is recognized as a reserve method and allowed to be used in cases when anatomical differentiation of changed abdominal wall tissues is impossible [13]. This is one of the simplest tension-free plasty, though the rate of wound complications is highest [56–58]. However, a number of surgeons in Russia and abroad use the technique successfully now [55, 59]. Onlay plasty in obese patients can be combined with dermolipectomy, horizontal abdominoplasty [59]. In surgical treatment of large ventral hernias, onlay method is combined with CST (components separation technique) and glue fixation of implant is performed [60].

The sublay technique means placing a mesh under the defect edges; the latter are sutured over the endoprosthesis. Some modern authors consider this variant of hernia repair as a method of choice [2, 61–63]. This plasty is the most reliable, but in some cases it is accompanied by an increase of intraabdominal pressure and cannot be referred to as tension-free. Sublay technique should not be used if the size of abdominal wall defect is more than 15 cm. Some authors maintain an attitude of «tolerable» intra-abdominal hypertension and consider certain levels of intraperitoneal pressure to be relatively safe [64–66]. Other surgeons point out the necessity of careful monitoring of intraabdominal pressure, especially in emergency surgery [18, 67].

The inlay method refers to truly tension-free procedures. According to the principles of modern hernia surgery a mesh is placed under edges of abdominal wall defect, but the edges are not sutured [2, 18, 61]. Inlay is considered to be a method of choice in cases when sublay technique is unfeasible [13, 58, 61].

The influence of implantation technique on the results of treatment is an outstanding question of hernia repair. Direct contact between endoprosthesis and subcutaneous fat (it is possible by inlay or onlay) contributes to seroma formation, purulent complications that therefore results in hernia recurrence [57, 58].

The contact between a mesh and abdominal cavity

organs can be a cause of severe complications [49]. Many surgeons recommend preperitoneal placement of a mesh. Some foreign clinics give preference to sublay retromuscular technique (SRM). According to this method, the mesh is implanted behind the abdominal rectus muscles, in front of the posterior sheath [68, 69]. SRM is associated with minimal recurrence rate (2–12%), best anatomical and functional reconstruction of abdominal wall [68, 70]. In cases of large defect, SRM is recommended to be combined with CST [70, 71]. In Russia some authors have a positive attitude towards SRM [13, 72], others accept its use, but prefer preperitoneal placement of mesh [2, 61]. There are surgeons who do not share the opinion and consider SRM to be difficult to understand, traumatic, and hard-to-explain in a technical sense [58]. This method is acceptable for minimal defect sizes; if hernia orifices are large, the complete placement of a mesh in retromuscular space is unfeasible. In such cases the IPOM is considered as the method of choice — alternative way of abdominal wall repair in hernia M and L (according to Chevrel–Rath classification) [73].

IPOM technique provides the placement of mesh in abdominal cavity with complete overlap of hernia orifices. This plasty can be performed as sublay or inlay depending on defect size and intraabdominal pressure [73–75]. In small hernias the first method is used, in cases of large hernias — the second way [53, 73, 76–79]. The operation can be performed by open approach or laparoscopically [76, 77, 80, 81].

The basic material for tension-free plasty is polypropylene. Literature describes the development of enteral and colonic fistulas after using such mesh [82, 83]. Around the polypropylene meshes dense fibrosis capsule forms [34]. It was emphasized in the 3rd Congress of Moscow surgeons that chronic inflammation in the area of implantation does not remit. There are experimental and clinical data on the development of bowel obstruction and fistulas after using meshes made of any material including those called antiadhesive meshes (polytetrafluorethylene, polyester) [84–86].

There are known the following ways to prevent IPOM complications: new technique of mesh isolation, antiadhesive coverings, perfect synthetic materials and alternative methods of endoprosthesis fixation. For separation of the mesh from intestinal loops there is used greater omentum, dissected peritoneum and hernia sac [61, 75, 87–90]. The authors observed no intestinal fistulas. Other researchers report on single events of such complications [80]. However, in a number of cases it is impossible to isolate a mesh from abdominal organs, since there is no sufficient area of omentum due to previous surgeries and diseases, and wide dissection of hernia sac or peritoneum results in their necrosis. Moreover, the larger defect of abdominal wall, the more complicated technically the separation is.

Currently, IPOM involves the use of composite meshes with different properties of surfaces [48, 53, 77]. Parietal surface of a composite mesh is designed so that it has good adhesive properties and serves as a basis for connective tissue formation. Visceral surface is produced smooth, made of antiadhesive material. There are also used coverings made of collagen, fetal fibroblasts, decellularized autodermal matrix, mesenchymal stem cells [91–95]. The experimental data and clinical experience of IPOM use with composite meshes turned out to be positive [96, 97]. Their use is possible even under the conditions of bacterial contamination [98]. The biological implants (xenopericardial) have made a good showing [99]. The use of new synthetic materials (reperene, polyvinylidene fluoride) is promising, but the experience of their application is relatively small [15, 34, 100–102]. Unfortunately, in some cases, in early postoperative period after IPOM using meshes made of some composite antiadhesive materials, an expressed adhesive process in abdominal cavity evelops, though no significant differences between the polypropylene mesh implantation and the composite endoprosthesis are observed [92, 93]. In some cases, the acute adhesive intestinal obstruction and even an intestinal fistula are known to be found in early postoperative period [10, 61, 85]. However, many authors believe than the danger of contact between the mesh and visceral organs is clearly exaggerated, and the position of intraperitoneal polypropylene mesh is not associated with intestinal fistula formation [74, 103].

Intraperitoneal plasty is possible to use under observation of some conditions both in planned and urgent surgery [10, 18, 73–75]. The impact of an edge of a mesh on the intestine has been shown to be dangerous rather than the contact of the mesh and intestinal loop [104]. Aseptic inflammation is proved to develop quickly along the peripheral zone of mesh implantation compared to the central area of plasty [34]. It is possible that suturing tissues in areas of mesh fixation results in hypoxia and local acidosis, which is the cause of the rapid migration of neutrophils in this area. The sutureless fixation of mesh is possible with the use of specially designed implants [105]. The more interesting and advanced version is glue endoprosthesis fixation [106]. The described advantages of this method have morphological justification. Uneventful reparative process is observed after intraperitoneal mesh implantation in comparison with other implantation techniques, and this pattern is universal and does not depend on the material of mesh [34]. The shrinkage effect is minimal exactly after IPOM [31, 32, 107]. Sutureless fixation of mesh using adhesive compositions results in low adhesive process in abdominal cavity [108].

IPOM is a simple and reliable method that is successfully used in any size hernia repair, as well as in preventive plasty of abdominal wall [52, 73, 75, 109–111]. Open IPOM is a procedure of choice in patients with high risk of wound complications [77]. This technique is appropriate for laparoscopic surgery [80, 81]. The analysis of similar and contrary opinions expressed by different authors suggests that the larger the defect of the abdominal wall and the higher the risk of recurrence, and the more manipulations in abdominal cavity (total adhesiolysis, simultaneous interventions) should be carried out in the abdominal cavity — the more arguments for the use of IPOM technology. An urgent situation, the severity of a patient's condition, the need to reduce the operation time and risk should also be considered as indications for IPOM. Initially high intra-abdominal pressure, obesity, wound contamination, diabetes mellitus, and advanced age can

be referred to significant factors to select the method by intraperitoneal plasty. Certainly, in this case it is essential to use a technique an operating team is familiar with and take into consideration the properties of synthetic materials which surgeons have at their disposal. The key condition of large-scale implementation of intraperitoneal plasty and complete realization of its advantages is the use of modern and available composite implants [112]. Currently, in Russia a variety of new materials for such implants is in the process of experimental and clinical study of [97, 100, 101, 112].

Conclusion. Intraperitoneal plasty of abdominal wall with synthetic mesh use is a simply and reliable method in hernia repair. The risk of complication after IPOM should be considered exaggerated. The development and implementation of composite meshes with different properties of surfaces is necessary now.

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