



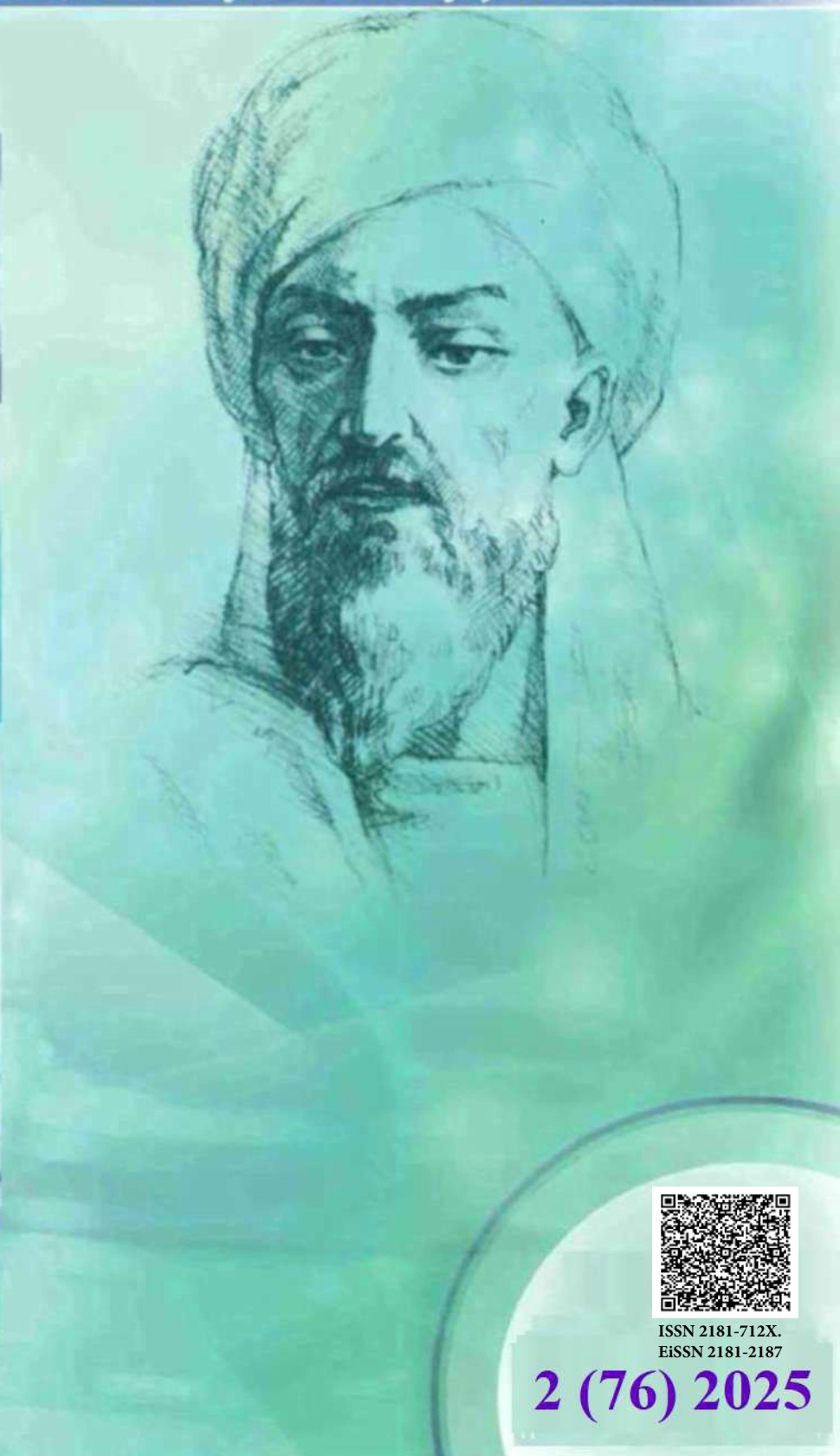
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**ТИББИЁТДА ЯНГИ КУН
НОВЫЙ ДЕНЬ В МЕДИЦИНЕ
NEW DAY IN MEDICINE**

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Научно-реферативный,
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COMPARATIVE EFFICIENCY OF A MODIFIED METHOD OF INGUINAL HERNIA ALLOPLASTY IN THE EXPERIMENT AND IN THE CLINIC

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✓ Resume

Objective. The aim of the research was to modify the alloplasty of inguinal hernia (IH) known by the name of Lichtenstein's surgery.

Materials and methods. The work is structured from two directions for research. In the first stage of the research were aimed at modification of the operation. To substantiate the effectiveness of the proposed modifications at the first stage, an experimental morphological study was performed. Laboratory rats ($n = 32$) were used in the work.

The second direction study was a clinical analysis of the effectiveness of the proposed surgical method. The study was conducted on 151 patients with IH. The main group included 73 patients, who underwent hernioplasty according to the proposed technique. The comparison group included 78 patients, all of whom underwent Lichtenstein's surgery. The patients were examined 7 days later and 1-3-6 months after the operation. Chronic pain and cremasteric reflex were examined in patients.

Results 1-3-5-7-14-21 days after the operation, pathomorphological studies were performed in rats. It was found that in the early postoperative period after plastic surgery in the comparison group, swelling and inflammation in the area of the spermatic cord, an increase in the size of the testicle were noted. Whereas in the experimental group, such changes were less developed.

This study revealed a decrease in postoperative pain, and the preservation of the cremasteric reflex was also observed on the 7th day and 1, 3, 6 months after surgery in the main group.

Conclusion: Modified method of alloplasty of IH improves surgical results.

Keywords: Chronic pain; Cremasteric reflex; Inguinal Hernia; Lichtenstein's surgery; Mesh

Relevance

The inguinal hernia is one of the common surgical diseases. Worldwide, approximately 20 million patients with inguinal hernia undergo surgery per year [4,5,6]. Despite the large number of works in this field, the incidence of recurrence of this disease remains at a rather high level. Despite the long history of development of inguinal hernia surgical repairing methods, as well as the development and implementation of alloplasty by open and laparoscopic methods, the problem of reducing the incidence of complications, as well as recurrences remains relevantly high [1,2,3].

Among the methods of inguinal hernioplasty, Lichtenstein plasty is currently used in the West [9], which has become the "gold standard" in the treatment of inguinal hernias, and in Uzbekistan as well this type of inguinal alloplasty is widely spread. According to some authors the cases of recurrences in Lichtenstein's hernioplasty are less common and do not exceed 5% [1,5,10]. This is confirmed by the European Hernia Trialists Collaboration, it also reports about the reduction of pain duration in comparison with local tissue plasty [7,8,10].

With the introduction of the Lichtenstein's inguinal canal plasty, this problem seems to be solved - i.e. the mesh opening no longer allows hernia development in the area of the internal inguinal canal opening. However, other problems such as the risk of infection of the mesh, its migration, impingement of the spermatic cord in the mesh opening, growth of scar tissue in the area of contact

between the spermatic cord and polypropylene mesh, etc. have appeared [7,8]. The development of neuralgia in the late postoperative period is noted in 35% of patients [7,8,10].

Objective. The aim of the research was to modify the Lichtenstein's alloplasty of inguinal hernia by forming a cuff around the spermatic cord in the place of the hole in the mesh, which protects it from scar tissue growth and subsequent deformation of spermatic cord.

Materials and Methods

The work is constructed from two directions for the study. Taking into account the main idea of the work - reduction of the frequency of specific postoperative complications characteristic for prosthetic plasty for inguinal hernia (IH) according to the Lichtenstein's technique. The research was aimed at modification of some technical moments of the operation. To substantiate the effectiveness of the proposed tactical and technical modifications at the first stage an experimental and morphological study was carried out, the results of which allowed to develop an improved method of alloplasty for IH and to introduce it into clinical practice. The studies were carried out in the laboratory of experimental surgery of the State Institution Government agency Republican Specialized Scientific and Practical medical Center for Surgery named after acad. V.Vakhidov (GA RSSPMCS named after acad. V.Vakhidov) for 2021-2023, laboratory rats (white, mongrel males weighing 180-250 grams) were used in the work (Table 1). Animals were kept in the vivarium of the centre, equipped according to the requirements of **Sanitary-epidemiological Control** for veterinary laboratories. Animals were kept in cages of 2 animals each with sufficient food and constant supply of drinking water. Surgical interventions were performed according to the requirements for humane treatment of laboratory animals in experiments (Strasbourg, 18.03.1986, as well as with the consent of the ethical committee at the State Institution GA RSSPMCS named after acad. V.Vakhidov).

Table 1. Distribution of laboratory animals into groups

No.	Groups of animals	1 day	3 day	5 day	7 day	14 day	21 day
1	Control	3	3	3	3	2	2
2	Experience	3	3	3	3	2	2
	Total 32	6	6	6	6	4	4

Note: The table does not include animals that were withdrawn from the experiment for other reasons (technical errors during surgery, anesthesia overdose, etc.) - a total of 4.

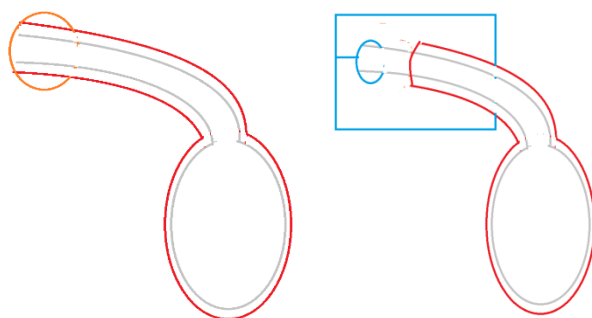
Methods of research. At different terms after the performed operation (1, 3, 7, 14 and 21 days) the animals were taken out of the experiment and the area of surgical intervention was studied by visual control, data registration on the camera with high resolution (20MP), as well as tissue biopsy for histological studies.

Methods of surgical intervention in the experiment (control). Under general anaesthesia with isoflurane inhalation, the rat was placed on the operating table in the supine position with the limbs separated and fixed. The hair cover in the right inguinal-scrotal region was removed. The surgical field was treated with betadine solution. A 1.5 cm long incision parallel to the right inguinal fold was made. Mobilisation of the anterior abdominal wall and the spermatic cord was done. In the seminal canal there is a peritoneal pocket of the type of congenital inguinal hernia containing the testis. The peritoneum is dissected, the elements of the seminal canal are highlighted. A 2x2cm Niprocel mesh is dissected up to half. The spermatic cord was strengthened in the slit of the dissected mesh, the edge of the dissected mesh was sutured. The mesh was placed on the anterior abdominal wall and spread on its surface. The testicle is located in the scrotum. The skin was continuously sutured. Treatment of the suture area with Betadine solution.

The technique of surgical intervention in rats in the experimental group. Under general anaesthesia with isoflurane inhalation the rat was placed on the operating table in the supine position with the limbs spread and fixed. The hair cover in the right inguinal-scrotal region was removed. The surgical field was treated with betadine solution. A 1.5 cm long incision parallel to the right inguinal fold was made. Mobilisation of the anterior abdominal wall and the spermatic cord was performed. In the

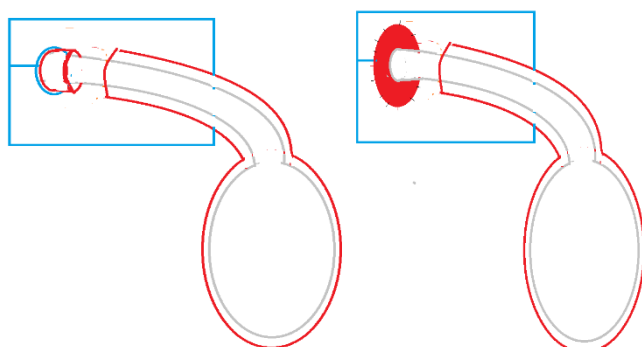


seminal canal there is a peritoneal pocket of the type of congenital inguinal hernia containing the testis. The peritoneum is dissected, the elements of the seminal canal are highlighted. A 2x2cm Niprocel mesh is dissected up to half. The spermatic cord is fixed in the slit of the dissected mesh above the peritoneum intersection, i.e. in such a way that the spermatic cord remains enveloped by the peritoneal sheets. The stumps of the crossed peritoneum and muscles are fixed around the perimeter of the mesh opening. The mesh is placed on the anterior abdominal wall and spread over its surface. Irradiation of the operative intervention zone with Matrix-2 laser for 1 minute in defocused mode. The testicle is located in the scrotum. Continuous suturing of the skin. Treatment of the suture area with Betadine solution. In the postoperative period, Sogdiana laser irradiation for 2 min was performed for 3 days.



A B

Figure 1. Anatomy of the seminal canal and inguinal canal in the rat. The type of structure resembles a congenital hernia in humans (A). Alloplasty of inguinal hernia in control (B).



A B

Fig.2. Alloplasty by the modified method. Stage of crossing the muscles of the spermatic cord and peritoneum (A). The stage of forming a cuff from peritoneum and muscles of the spermatic cord around the hole in the mesh (B).

When performing surgical intervention in rats, it should be taken into account that the testis and the spermatic cord are located in a wide pocket of the peritoneum and enveloped by the muscle, the fibers of which pass directly into the muscles of the anterior abdominal wall. Careful dissection and crossing of the muscle fibers ensures the integrity of the vessels of the spermatic cord. The wide (hernia) opening is sutured with Z-shaped sutures.

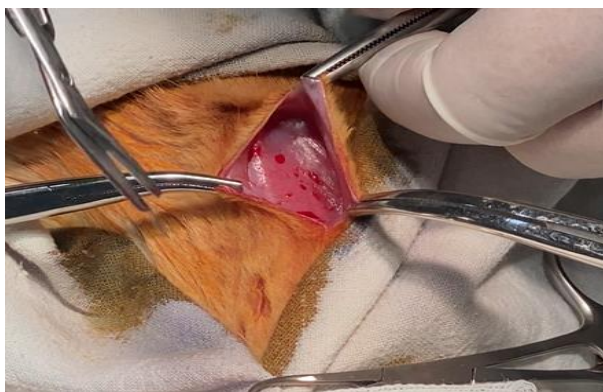


Fig.3 Stages of inguinal hernia plasty. Dissection of the skin separation of the anterior abdominal wall



Fig.4. The stage of fixation of the mesh to the anterior abdominal wall

When performing alloplasty in the comparison group of animals, the seminal canal, which is previously separated from the peritoneum, passes directly through the mesh. In the experimental group of animals, the peritoneal stump protrudes above the mesh, which is subsequently spread along the perimeter of the mesh opening. Irradiation of the mesh attachment zone and the wound with Matrix 2 laser radiation for 1 minute in the ultraviolet range was carried out. In the comparison group of animals, irradiation was not performed.

In the postoperative period animals of both groups fully recovered in 30 min and actively moved around the cage. During 3 days anesthesia was carried out by taking ibuprofen together with drinking water. Animals of the experimental group were irradiated with Sogdiana laser with power 3W and frequency 80Hz for 1 min on the area of the surgical wound once a day during 3 days.

Results of experiment

When the animals were taken out of the experiment on the 3rd day it was found that in the comparison group of animals there was oedema and infiltration of the seminal canal in the area of the performed plasty. The right testicle was edematous and slightly increased in size. There was a dense infiltrate in the area of passage of the spermatic cord through the mesh hole with formation of dense fusions.



Figure 5. 3-day post-Lichtenstein operation. Control. On the side of the operation performed, edema of the spermatic cord and enlargement of the right testis can be seen. The mesh is attached to the anterior abdominal wall without signs of infection.



Fig.6. Experiment. 3 days after inguinal hernia repair by modified method. The testicles are equal in both sides. Tissue oedema is insignificant. (Operation on the right side).



Fig.7. Experience of 7 days. Area of passage of the seminal canal through the opening in the mesh. The testis is not enlarged. The spermatic cord passes through the opening in the mesh. Tissue oedema is insignificant.



Fig. 8. Control 7 days. The area where the spermatic cord passes through the window in the mesh. A seam is visible that closes the edges of the dissected mesh. Swelling and infiltration of spermatic cord tissue is significant.

On 14 and 21 days after the operation the animals were active, practically did not differ from healthy individuals. On palpation, the right testis of the rats remained in the scrotum, whereas the left one retracted into the abdominal cavity. On palpation the side of the surgery was painless.

When the rat was taken out of the experiment, ingrowth of the mesh into the tissue of the anterior abdominal wall was noted. In the comparison group of animals it was technically impossible to separate the spermatic cord from the opening in the mesh because of rough scar tissue fusion. In the experimental group, the spermatic cord was separated by destroying the muscular sheath of the spermatic cord and peritoneum. No signs of inflammation in the tissues were noted.

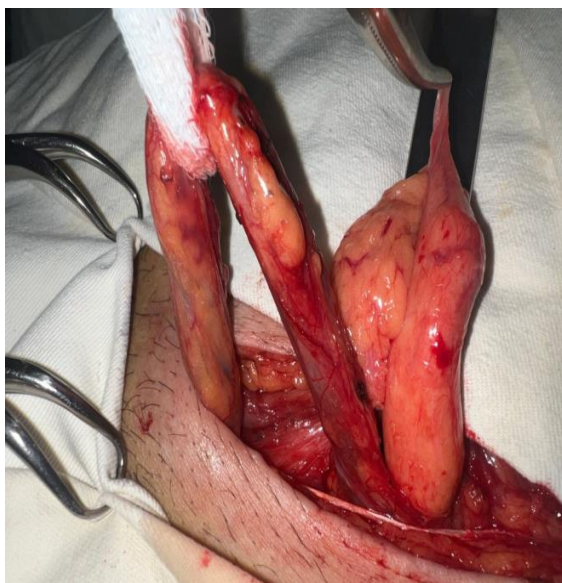
In the experiment on rats the operative intervention was performed according to the type of operations at congenital inguinal hernias. In control group the seminal canal was in direct contact with the hole in the polypropylene mesh, whereas in the experimental group a cuff was formed at the expense of the muscular sheath and peritoneal outgrowth of the peritoneum.

It was found that in the nearest terms of the operation after plastic surgery in the comparison group there was oedema and inflammation in the area of the spermatic cord, increase in the size of the left testicle. Whereas in the experimental group such changes were less observed.

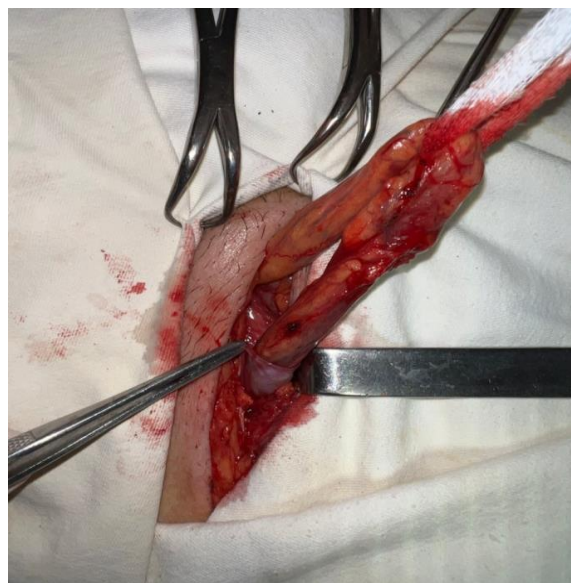
The second focus of the study was clinical analysis of the effectiveness of the proposed method of surgery. The study covered the evaluation of the results of inguinal hernia plasty in 151 patients. All patients were male. Two clinical groups for comparison were formed. The main group included 73 patients with IH who underwent hernioplasty using the proposed technique between 2023 and January 2024. The comparison group included 78 IH patients, comparable in basic clinical criteria to the patients in the main group, all of whom underwent Lichtenstein surgery for 2021-2022. Conventional mesh prostheses (Esfil, Prolene) were used in IH plasty in both groups.

The patients of the main group underwent the improved method of Lichtenstein's operation, which the method of inguinal hernia alloplasty has the following distinctive features: after opening of the hernia sac and repositioning of the hernial contents into the abdominal cavity, the hernia gate is sutured from the inner side of the hernia sac with a cicatricial suture. Preservation of the hernia sac walls, which 'wraps' (enveloping by the walls of the preserved hernia sac) the spermatic cord, protects it when passing through the hole in the mesh prosthesis (MP). The opening in the MP is sutured with a knotted suture using Prolene 3/0 thread, then the free part of the peritoneum of the hernia sac is cut off at a distance of 1.0-1.5 cm from the specified hole. The remaining part of the peritoneum around the spermatic cord is fixed along the perimeter to the hole in the MP in the form of a cuff. Fixation of the MP is done in standard points, the spermatic cord is placed over it, before suturing the sheets of the external oblique abdominal muscle with the formation of the external opening of the inguinal canal. The wound is sutured layer-by-layer.

The patent for invention of the Ministry of Justice of the Republic of Uzbekistan No. IAP 20230698 dated 08.01.2024 ("Method of inguinal hernia alloplasty") was obtained for this method.



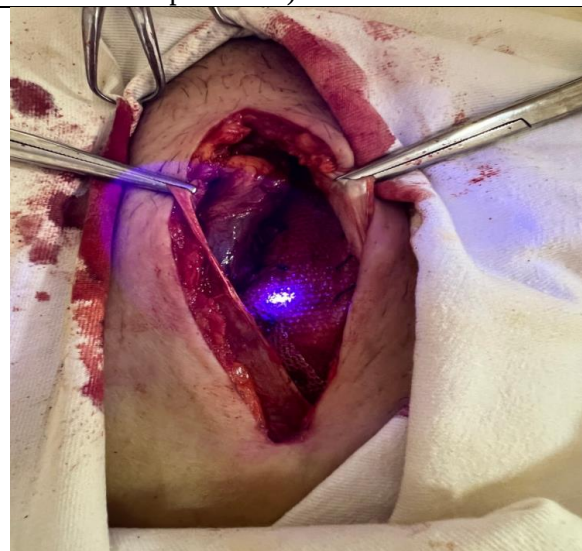
Hernia sac exposed and the spermatic cord taken on a holder



Severed hernia sac with preservation of part of the wall (to cover the spermatic cord in the area of exit from the prosthesis)



The portion of the hernia sac fixed to the prosthesis, enveloping the spermatic cord



Irradiation of the wound area with prosthesis with Matrix 2K laser

Fig. 9

A study of early postoperative complications after inguinal canal plasty using the improved Lichtenstein's method does not reveal any complications characteristic of this operation. Fluid accumulation is considered a frequent complication after alloplasty. Seroma formation in the periprosthetic space in the postoperative period was noted in 8 (10.9%) observations.

Almost all patients became active on the 1-2 day. The postoperative period in the patients operated on by us proceeded without complications. The patients were treated with appropriate antibacterial therapy in the department. Postoperative physiotherapeutic complex of anti-inflammatory measures was performed in all patients, the complex included: early activation (within a day after the intervention), irradiation with Sogdiana laser with the wavelength of 998 nm, frequency 80 Hz, power 7W in pulse mode, duration 3 minutes daily during 3-7 days.

Outcomes

After the operation, the condition of the patients was re-examined on 3-5 days and 1-3-6 months, the condition of the cremaster reflex was studied in the patients. Groin symptoms were positive. If the patient had experienced pain in the operated inguinal area during the last month, pain sensation was recorded from 0 to 10 using a visual analogue scale (VAS). Chronic pain was defined as pain rated VAS C 3 limiting normal activity.

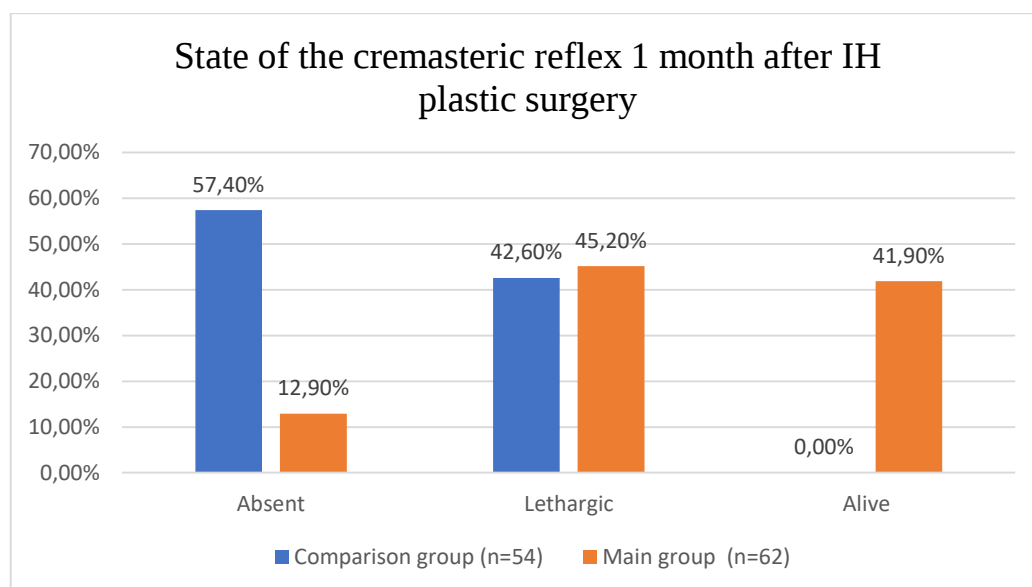
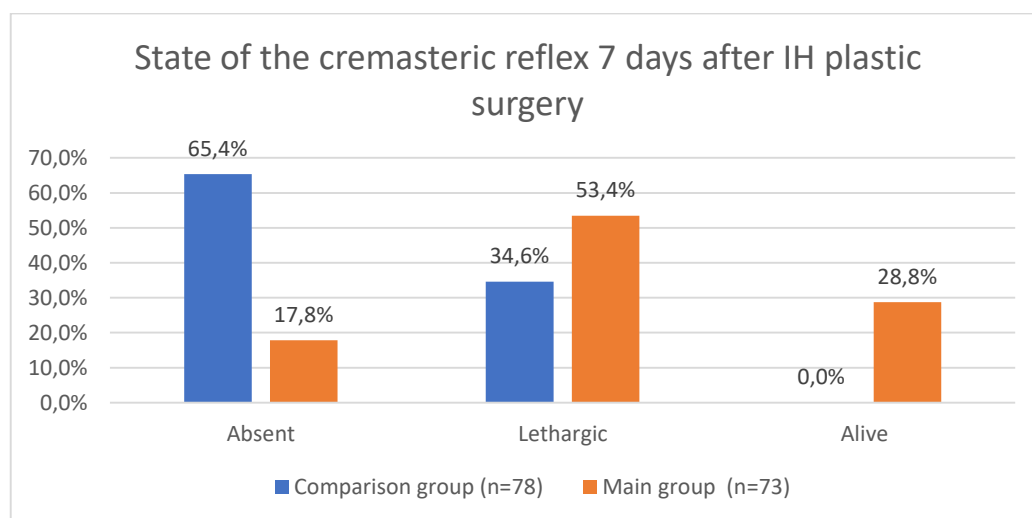
The primary outcome of this study was the evaluation of the cremasteric reflex. Secondary outcomes were pain (VAS ≥ 3) at 6-month follow-up.

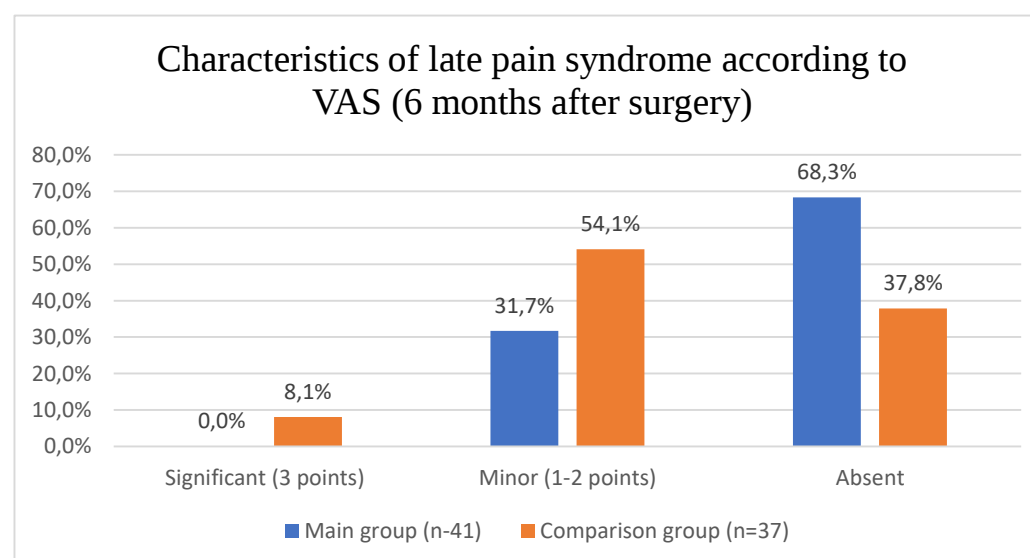
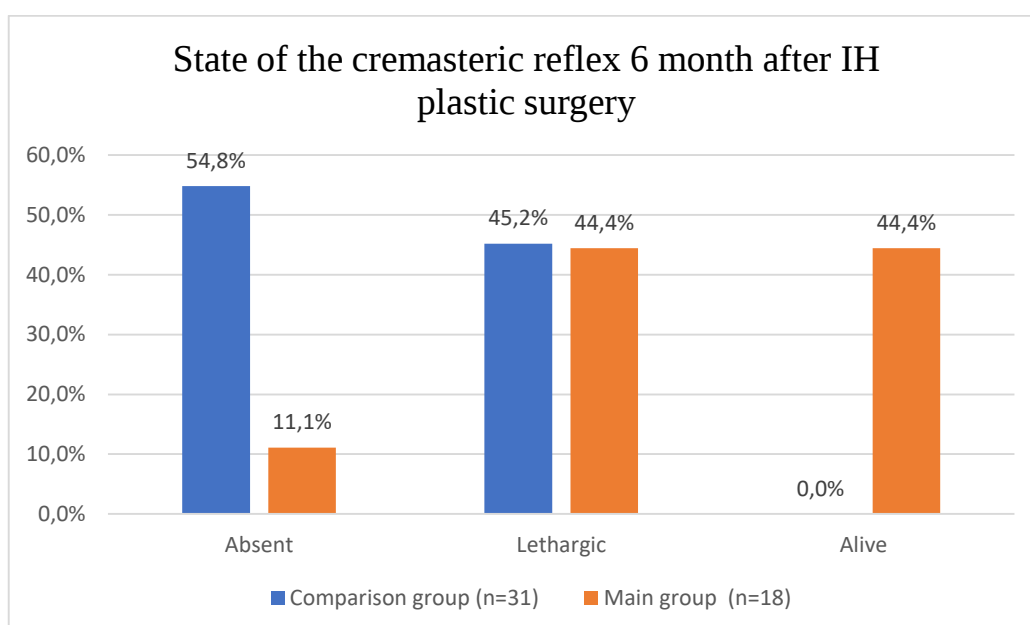
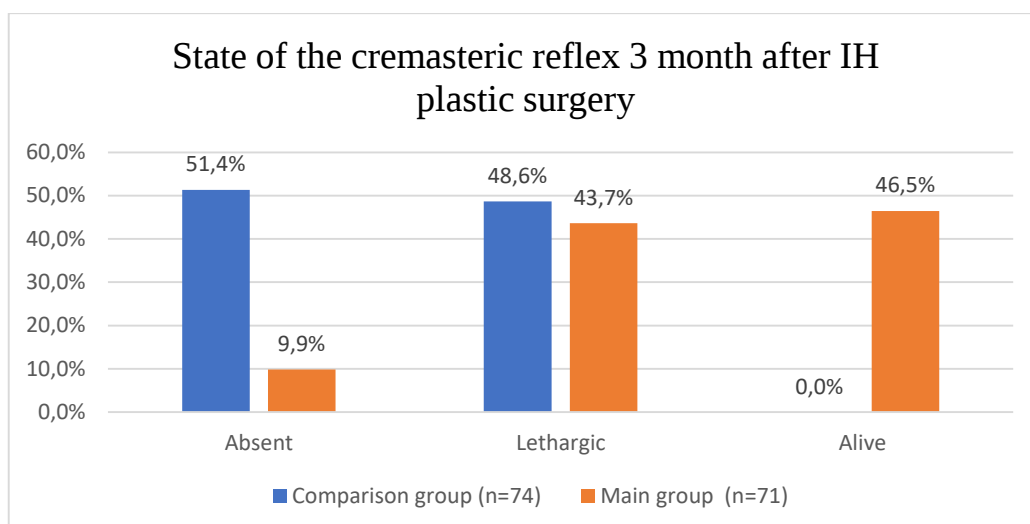
In all observations the patients were discharged from the hospital in satisfactory condition on the 3-4th day, wound healing by primary sutures.

Statistical analysis

Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows (IBM SPSS Statistic 22.0, USA). For categorical variables, we used Pearson's Chi-squared test or Fisher's exact test, for numerical variables independent samples test or Mann-Whitney U test. A P ≤ 0.05 was considered statistically significant. An assessment of the normality of data was performed using SPSS statistic (explore command).

Evaluation of the cremasteric reflex state. The study was carried out 5-7 days after the operation and further in 1, 3 and 6 months. All cases with testicular displacement showed a positive cremasteric reflex, i.e. its preservation after plasty. A live reflex, that is, a full reflex, was registered when the upper pole of the testis reached the root of the scrotum.





Discussion

Matikainen, M. et al. [7] states that, mesh fixation may affect chronic pain and recurrence after inguinal hernia surgery. Less fixation does not mean less pain in long-term follow-up. Many different methods of endoprosthesis fixation such as self-gripping mesh or suture fixation are currently used. Less penetrating fixation (adhesive or self-gripping mesh) is a safe option for mesh fixation in Lichtenstein hernia repair. There was no statistically significant difference in pain scores, hernia recurrence rates, or satisfaction with surgery after 5 years between adhesive fixation, self-gripping mesh, or suture fixation. This can give both the surgeon and the patient a choice of different operative techniques to perform open inguinal hernioplasty. The authors recommend the use of LWM in open inguinal hernia repair.

Sultan. A. et al. [8] conducted a study to compare Lichtenstein open inguinal hernia repair and laparoscopic transabdominal preperitoneal inguinal hernia repair (TAPP) for unilateral non-recurrent hernia in terms of intraoperative, postoperative complications and hospital stay. The authors reported that inguinal hernia repair with TAPP is safer and less painful in the early postoperative period. It also has fewer complications but significantly increases the operative time.

A systematic review and meta-analysis conducted by Wackeg, W. J., et al [9] demonstrated that LWM should be used in open inguinal hernia repair (Lichtenstein). The use of LWM instead of HWM results in a 22% reduction in the number of patients with chronic pain and a 36% reduction in the number of patients with foreign body sensation. Since the recurrence rate is likely to be the same, the benefits to patients are undeniable and outweigh the (social) disadvantage of the higher price of LWM. For any chronic groin pain and foreign body sensation, the data favour the use of LWM in open inguinal hernia repair.

Chen, J. et al. [10] argues that, laparoscopic inguinal hernia repair is associated with less chronic groin pain, earlier return to work, faster recovery and improved quality of life compared to open access. Based on current and available evidence, the inguinal hernia repair that optimises longevity, reduces chronic pain, optimises quality of life and accelerates postoperative functionality, all at minimal overall cost to the healthcare system, is laparoscopic.

The method of inguinal hernia alloplasty known under the name of Lichtenstein's operation was modified by forming a cuff around the spermatic cord in the place of the hole in the mesh, which protects it from scar tissue overgrowth and subsequent deformation.

Conclusions

The modified method of alloplasty of inguinal hernias allows significantly levelling the edema and scarring in the place of the seminal canal contact with the hole in the polypropylene mesh, and the performance of additional measures as laser irradiation allows improving the results of the operations by preventing the scarring process

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