CLINICAL AND LABORATORY ASSESSMENT OF ONLAY ALLOPLASTY USING LIGHT AND HEAVY POLYPROPYLENE MESHES IN VENTRAL HERNIAS

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Abstract. *The article discusses the outcomes associated with the use of polypropylene-light and polypropylene-heavy endoprostheses in the allohernioplasty of ventral hernias conducted in the onlay position. A comparative analysis of the two types of polypropylene materials revealed superior biocompatibility of the polypropylene-light endoprosthesis (designated as the main group) when compared to the polypropylene-heavy variant (designated as the control group). Notably, the main group exhibited a less pronounced exudative phase of inflammation and a more rapid onset of the proliferation phase. The incidence of postoperative wound complications was recorded at 9.6±3.5% in the main group and 17.2±4.8% in the control group.*
Keywords: *postoperative ventral hernias, alloplasty, polypropylene mesh.*

Introduction. Abdominal hernias represent one of the most prevalent surgical conditions, affecting approximately 4-7% of the adult population. The incidence increases to 5-12% among patients following laparotomy, with postoperative ventral hernias occurring in this group [1,4,6,10,13]. When utilizing autologous tissue for repair at the hernial orifice, the recurrence rate of hernias can reach as high as 46-53% [5].

The primary surgical approach for the treatment of postoperative ventral hernias (POVH) is tension-free herniorrhaphy [10,11]. Currently, a variety of high-strength, elastic, and biocompatible implant materials with favorable physical and mechanical properties are available [2,7,10,12]. Hernioplasty mesh endoprostheses are classified as heavy, standard, or light based on their structural characteristics and thread diameter [3,8]. Lightweight meshes, in particular, exhibit enhanced biocompatibility due to the reduced quantity of foreign material introduced into the tissue, resulting in improved compatibility between the endoprosthesis and the host tissue [3,6,14].

Research Objective: The objective of this study is to evaluate the clinical and laboratory outcomes associated with the use of light versus heavy polypropylene (PP) mesh in the context of postoperative ventral hernias, as well as to review relevant clinical research findings.

Materials and Methods. In this study, we evaluated a total of 137 patients, who were classified into two distinct groups: a comparison group consisting of 64 patients and a main group comprising 73 patients. In the comparison group (Group I), a Polypropylene-heavy endoprosthesis was utilized, while in the main group (Group II), a Polypropylene-light endoprosthesis was employed. All participants underwent endoprosthetic repair of abdominal wall defects utilizing the onlay technique.

The demographic and clinical characteristics of both groups are detailed in Table 1. The data indicates that the groups were statistically comparable with respect to gender, age, and the types and sizes of ventral hernias presented by the patients.

As the first phase of our analysis, we assessed the body temperature response to the Polypropylene-heavy and Polypropylene-light implants from a comparative perspective. The resulting dynamics of the temperature response are illustrated in Figure 1.

Table 1

Distribution of patients by gender and age in groups

Groups of patients (=137)			Comparison group (p=64)		Main group (p=73)	
			abs.	%	abs.	%
Age (years)	till 20	m	-		-	
		f	-		-	
	20-39	m	1	1,6±1,6	1	1,4±1,4
		f	2	3,1±2,2	3	4,1±2,3
	40-59	m	3	4,7±2,7	5	6,8±3,0
		f	27	42,2±6,2	29	39,7±5,8
	60-74	m	5	7,8±3,4	6	8,2±3,2
		f	24	37,5±6,1	26	35,6±5,6
	75 + <	m	1	1,6±1,6	2	2,7±1,9
		f	1	1,6±1,6	1	1,4±1,4

Results and Discussion. In a study involving 64 patients from the comparison group using "Polypropylene heavy" drains, it was observed that the patients maintained a subfebrile temperature for up to six days, with normalization occurring by the seventh day.

Conversely, within the main group of 73 patients utilizing "Polypropylene light" drains, a temperature increase was recorded for up to four days (as illustrated in Figure 1), followed by normalization on the sixth to seventh day.

Notably, in five patients from the main group whose drains were removed between the third and fifth days, a temperature increase from 37.5°C to 38.9°C was observed. This temperature elevation was attributed to the presence of seromas, which, upon evacuation, resulted in the normalization of temperature.

The temperature response observed in patients within the comparison group was significantly elevated compared to the main group throughout all phases of the study.

The postoperative dynamics of leukocyte counts (expressed in x10^9/l) based on the type of mesh utilized are illustrated in Figure 2. The data from this figure indicate that the leukocyte count in the control group increased from 8,000 to 10,000 over a period of six days, while in the main group, this increase was noted over five days.

Leukocytosis in the control group normalized by the seventh day, while in the main group, a return to baseline levels occurred by the sixth day. As depicted in Figure 2, elevated leukocyte levels in the peripheral blood were evident from the second day, displaying a gradual decline by the sixth to the seventh day of observation.

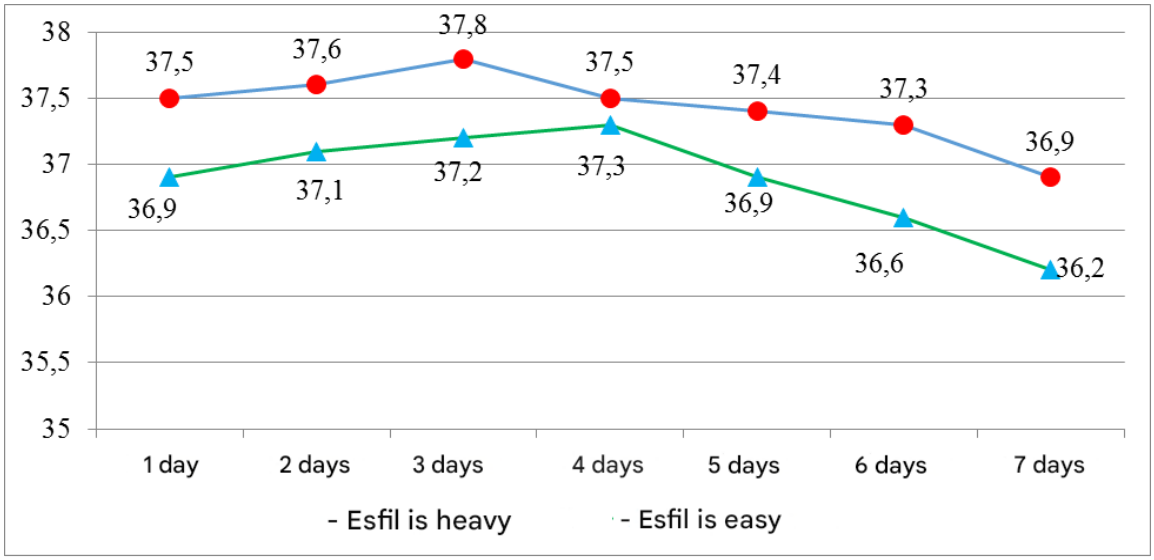

Figure 1. Dynamics of temperature reaction in the postoperative period depending on the type of mesh used.

Notably, in the comparison group, the leukocyte levels exhibited a tendency to gradually increase from the early postoperative stages, reaching peak values on days four and five, specifically measuring 12.4±0.41 and 12.5±0.42 (x10^9/l) respectively, before beginning to decrease towards the conclusion of the observation period.

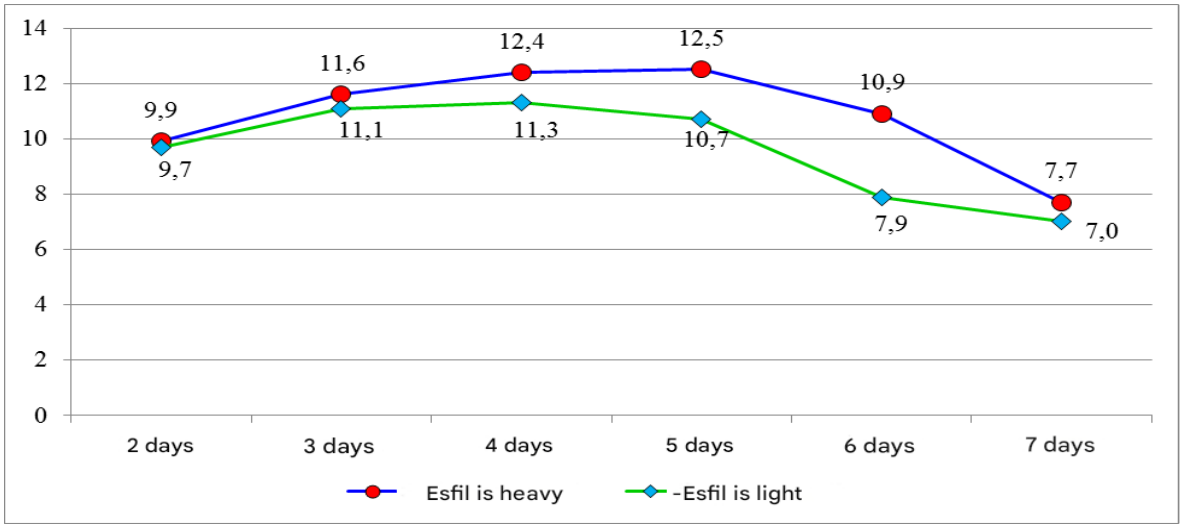

Figure 2. Dynamics of the level of leukocytes in the blood (x109/l) in comparison groups.

The analysis of discharges from surgical wounds yielded the following findings. It was conclusively determined that patients in the primary group exhibited hemorrhagic fluid discharge for one day post-surgery. Additionally, serous-hemorrhagic fluid was present for three days, followed by serous fluid observed on the fourth day in twelve patients. These patients underwent surgery for postoperative ventral hernias. In the primary group, serous discharge was noted in two patients on the fourth to fifth day post-operation. Furthermore, in the comparison group, 22 patients (34.3%) demonstrated paraprosthetic formations in the vicinity of the postoperative wound during the early postoperative period.

In contrast to the primary group, the patients in the comparison group exhibited an extended duration of wound exudate production, continuing for a total of six days. On the third day of the postoperative period, these patients demonstrated a peak fluid output of 61.4 ± 4.2 ml. Notable differences were observed in the dynamics of exudative responses between the two groups. In the

comparison group, exudation was significantly elevated during the early postoperative stages, gradually tapering off in the later stages. Conversely, the primary group exhibited a consistent decline in exudation, with a marked reduction by the third to fourth day. Notably, in 12 patients from the primary group, fluid output decreased to 20 ml by the fourth day, leading to the removal of drains following ultrasound assessment. The average duration of drainage for the primary group was recorded at 4.1 ± 1.1 days, while the comparison group experienced a longer duration of 6.1 ± 1.5 days.

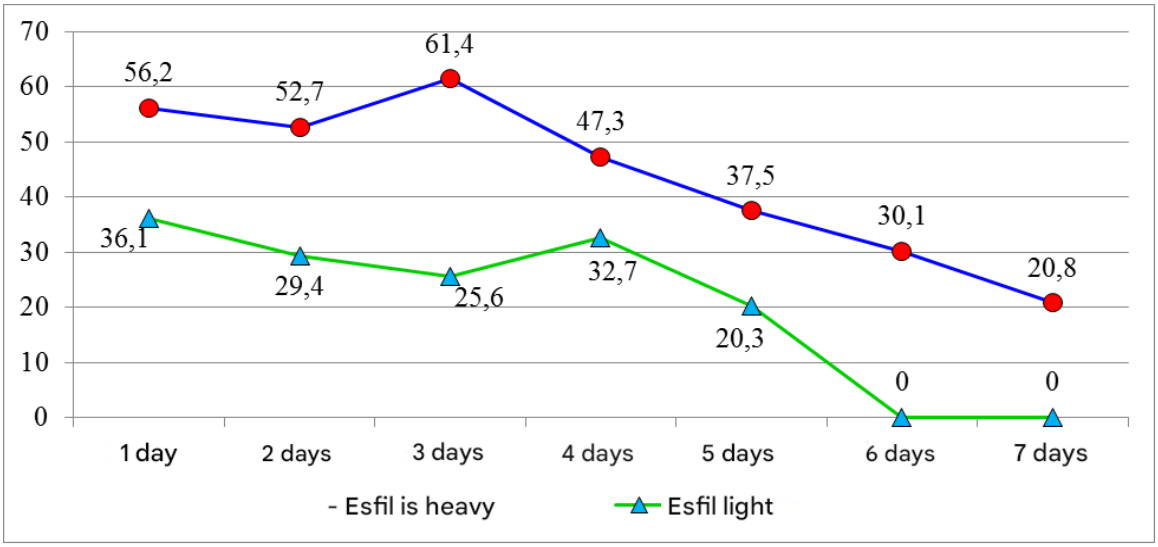

Figure 3. Dynamics of the volume of wound exudate in the postoperative period depending on the type of mesh used

In the postoperative period, continuous active aspiration of wound exudate was conducted through the drainage tubes placed within the wound cavity.

The results of the cytological examination of the wound secretion over time are summarized in Table 2. During the initial 1-2 days, the smears obtained from the paraprosthetic space in both the primary and control groups exhibited hemorrhagic characteristics due to the presence of erythrocytes. An analysis of the dynamic tissue response revealed an increase in the presence of cells associated with the mononuclear-phagocytic system from the 3rd to the 4th day, which are crucial for infection defense. Concurrently, there was a noted decrease in the levels of inflammatory cells.

Indicators reflecting the inflammatory phase of the tissue response, specifically the counts of granulocytes and lymphocytes, showed that the peak of inflammation occurred on the 3rd day following endoprosthesis implantation in both the comparison and primary groups. By the 5th day, there was a marked increase in macrophages and fibroblasts, indicating a transition in the wound healing process toward the reparative phase.

It is important to note that on the 5th day of the postoperative period, patients in the main group exhibited a less pronounced inflammatory response, as indicated by the quantitative ratio of granulocytes. In contrast, the fibroplastic response, measured by the presence of macrophages and fibroblasts in the wound discharge, was observed to be more pronounced compared to patients in the comparison group ($p \leq 0.05$).

Based on the analysis of discharge characteristics from the drains, it can be concluded that in the primary cohort of patients, the transition from an inflammatory type of discharge to a regenerative type occurs earlier than in the comparison cohort. Our investigation into the nature of the drainage discharge yielded the following results (refer to Table 3). In the primary group, the

shift from inflammatory to regenerative wound discharge was observed to occur two days earlier than in the comparison group. This suggests that the use of the Polypropylene-Light endoprosthesis, uniquely attributed to its structural characteristics, results in a wound healing process marked by a less pronounced inflammatory tissue reaction.

Table 2

Percentage of the main cellular elements in the cytological examination of wound discharge

Cellular elements	Polypropylene-heavy (n=64)			Polypropylene-light (n=73)		
	2 days	3-4 days	5-7 days	2 days	3-4 days	5-7 days
Granulocytes	55,0±1,8	43,0±1,5	39,0±1,3	53,0±1,7	40,0±1,4	35,0±1,2*
Lymphocytes	26,0±0,86	29,0±0,97	27,0±0,89	25,0±0,82	28,0±0,92	26,0±0,85
Macrophages	12,0±0,39	18,0±0,60	20,0±0,66	19,0±0,63***	19,0±0,64	23,0±0,76**
Fibroblasts	3,0±0,10	8,0±0,26	14,0±0,47	9,0±0,30***	9,0±0,29*	16,0±0,52*

Note: * - reliable compared to the comparison group (*-P<0.05; **-P<0.01; ***-P<0.001)

Table 3

The nature of wound discharge in the comparison group and in the main group

Time (days)	Control group (n=64)	Main group (n=73)
2nd	Degenerative-inflammatory	Degenerative-inflammatory
3rd - 4th	Inflammatory	Inflammatory-regenerative
5th -7th	Inflammatory-regenerative	Regenerative

The subsequent phase of the study focused on evaluating the immediate outcomes associated with the aponeurotic implantation of both heavy and light endoprostheses in patients who had undergone surgery for ventral hernias. In both the main and comparison groups, only isolated cases of systemic complications were recorded, with no statistically significant differences noted between the groups (refer to Table 4). Importantly, there were no reported fatalities observed in any of the cases.

Table 4.

Nature of systemic complications in comparison groups

Type of complication	Main group (n=73)		Comparison group (n=64)		P
	abs.	%	abs.	%	
IHD	1	1,4±1,4	2	3,1±2,2	>0,05
Iliofemoral thrombosis	2	2,7±1,9	1	1,6±1,6	>0,05
Tracheobronchitis	1	1,4±1,4	2	3,1±2,2	>0,05
Broncho-pneumonia	1	1,4±1,4	-	-	
Acute urinary retention	1	1,4±1,4	-	-	
Total patients with complications	6	8,2±3,2	5	7,8±3,4	>0,05
Total patients without complications	67	91,8±3,2	59	92,2±3,4	>0,05

In the comparison group, tracheobronchitis was observed in two instances, both of which were treated with nebulizer inhalation sanitation of the bronchial tree, incorporating the antibiotic Miramistin. One of these cases was identified as nosocomial. Additionally, there was one instance of ileofemoral thrombosis, which was confirmed via Doppler sonography as a fixed thrombus. Conservative treatment was conducted under the supervision of a phlebologist. In terms of cardiovascular events, two cases of angina pectoris were recorded in patients with a background of ischemic heart disease within the comparison group. The main group also reported one instance of angina pectoris against a background of ischemic heart disease. Furthermore, two cases of ileofemoral thrombosis were noted, with treatment administered in accordance with established protocols, involving the participation of a phlebologist.

In the main group, tracheobronchitis was treated in two cases through antiseptic inhalation and bronchial tree sanitation. There was also one case of bronchopneumonia in a patient with grade 4 obesity, which was classified as nosocomial pneumonia due to the patient's two-day stay on artificial ventilation. Additionally, acute urinary retention due to benign prostatic hyperplasia was reported in one instance, successfully managed through catheterization.

It is important to emphasize that the nature of the systemic complications observed does not appear to be related to either heavy or light mesh use. Table 5 delineates the structure of local complications experienced during the postoperative period in patients undergoing POVH.

Table 5

Nature of local complications in patients with POVH in comparison groups

Type of complication	Main group (n=73)		Comparison group (n=64)		P
	Abs.	%	Abs.	%	
Seroma	3	4,2±2,1	8	12,7±4,1	>0,05
Infiltrate	5	6,9±2,8	2	3,3±2,1	>0,05
Postoperative wound suppuration	1	1,4±1,4	2	3,1±2,2	>0,05
Hematoma	1	1,4±1,4	1	1,6±1,6	>0,05
Wound edge necrosis	1	1,4±1,4	-	-	-
Lymphorrhea	-	-	1	1,6±1,6	-
Total patients with complications	**7**	9,6±3,5	11	17,2±4,8	>0,05
Total patients without complications	62	84,9±4,2	50	78,1±5,2	>0,05

Complications following alloplasty of the hernial orifice utilizing Polypropylene Light and Polypropylene Heavy prostheses were noted in 11 patients (15.1%) and 14 patients (21.8%), respectively. Among the wound complications associated with phalloplasty, various issues were identified, including the formation of seroma, tissue infiltrate, suppuration of the postoperative wound, hematoma, marginal necrosis of the skin-subcutaneous-fat flap, and lymphorrhea.

Seroma in the residual cavity was diagnosed in 3 patients (4.1%) from the Polypropylene Light mesh group and in 8 patients (12.5%) from the Polypropylene Heavy mesh group. It is

recognized that this complication is primarily observed after allohernioplasty performed for giant hernias in the onlay position. To mitigate the risk of seroma, a pre-prepared bandage was applied to the abdomen immediately after the surgical procedure, and patients were instructed to wear this bandage during the early postoperative period to provide gentle compression to the tissues in the surgical area.

The average duration of postoperative hospital stay for patients undergoing alloplasty with the Polypropylene Light and Polypropylene Heavy mesh was recorded as 5.4 ± a minimal value and 6.1 ± 1.5 bed-days, respectively. Notably, the use of the Polypropylene Light endoprosthesis was associated with a less pronounced and shorter exudative phase of the wound process, resulting in an earlier onset of the proliferation phase.

Conclusions. 1. The evaluation of clinical and laboratory parameters regarding the application of heavy and light polypropylene mesh in phalloplasty indicated that the temperature response observed in the comparison group was significantly elevated compared to the main group. A moderate leukocyte reaction with fluctuations in leukocytosis ranging from 8,000 to 10,000 was noted without any shifts in the leukocyte differential over a span of six days. Notably, elevated leukocyte counts were prominent on the 3rd to 4th postoperative days. In the comparison group, leukocytosis showed normalization by the 7th day, while in the main group, it returned to baseline by the 6th day.

2. The use of the heavy polypropylene endoprosthesis for postoperative ventral hernias resulted in a marked prolongation of the exudative phase of inflammation, with a peak wound exudate measured at 61.4 ± 4.2 ml by the 3rd day. In contrast, the light polypropylene endoprosthesis demonstrated a peak of only 25.6 ± 4.2 ml. Between days 5 to 7, the wound healing process in the comparison group was characterized as inflammatory-regenerative, whereas the main group exhibited a predominantly regenerative nature.

3. An assessment of postoperative complications in patients utilizing light and heavy polypropylene endoprostheses revealed a higher incidence of complications associated with the heavy polypropylene group. Specifically, the occurrence of postoperative wound seromas was recorded at 12.5 ± 4.2% ($p < 0.01$) in the comparison group, compared to 4.1 ± 2.3% in the main group. Instances of wound suppuration were 3.1 ± 2.2% in the heavy group and 1.4 ± 1.4% in the light group, while the formation of infiltrates occurred at rates of 3.1 ± 2.2% and 6.8 ± 3.0% respectively ($p > 0.05$), suggesting a superior biocompatibility of the light polypropylene prosthesis relative to the heavy variant. The overall rate of postoperative wound complications was 9.6 ± 3.5% in the main group and 17.2 ± 4.8% in the comparison group.

REFERENCES

1. Abdumajidov A. et al. Complex treatment of Pyo-inflammational diseases in patients with diabetes mellitus //Central Asian Journal of Pediatrics. – 2019. – T. 2. – №. 3. – C. 57-59.
2. Akhmedov A. I., Tursumetov A. A., Zhafarov K. M. Features of allohernioplasty for postoperative ventral hernias in the on-lay position under conditions of infection in the experiment //European Journal of Molecular and Clinical Medicine. – 2020. – T. 7. – №. 3. – C. 3897-3905.
3. Akolekar D., Kumar S., Khan L.R. et al. Comparison of recurrence with lightweight composite polypropylene mesh and heavyweight mesh in laparoscopic totally extraperitoneal

inguinal hernia repair: an audit of 1,232 repairs // Hernia. 2008;12(1): 39-43. Doi: https://pubmed.ncbi.nlm.nih.gov/17851728/

4. Bringman S, et al. Three-year results of a randomized clinical trial of lightweight or standard polypropylene mesh in Lichtenstein repair of primary inguinal hernia. British Journal of Surgery: Incorporating European Journal of Surgery and Swiss Surgery. 2006; 93(9):1056-1059. Doi: https://academic.oup.com/bjs/article/93/9/1056/6142443 (6)

5. Fortelny, R.H. Abdominal Wall Closure in Elective Midline Laparotomy: The Current Recommendations / René H. Fortelny. – Text: visual // Frontiers in Surgery. 2018; (5):1-8 Doi: https://www.frontiersin.org/articles/10.3389/fsurg.2018.00034/full

6. Gonzalez R., Ramshaw B.J. Comparison of tissue integration between polyester and polypropylene prostheses in the preperitoneal space // Am. Surg. 2003; 69(6): 471-476. Doi: https://pubmed.ncbi.nlm.nih.gov/12852503

7. Jafarov K., Melnik I. Immediate Results of Surgical Treatment of Patients with Strangulated of Ventral Hernia of the Anterior Abdominal Wall //Asian Pacific Journal of Environment and Cancer. – 2021. – T. 4. – №. S1. – C. 13-14.

8. Meta-analysis on Materials and Techniques for Laparotomy Closure: The MATCH Review / N.A. Henriksen, E.B. Deerenberg, L. Venclauskas [et al.]. – Text: visual // World J Surg. 2018; 42(6):1687-1694 Doi: https://link.springer.com/article/10.1007/s00268-017-4393-9

9. Mirzakhidovich J. K., Abdumalikovich T. A., Ibrogimovich A. A. Prevention of Postoperative Wound Complications in Rappeded Abdominal Hernia //Annals of the Romanian Society for Cell Biology. – 2021. – T. 25. – №. 1. – C. 6473-6484.

10. Nancharaiah, Dr. P. A clinical study of abdominal wound dehiscence and its management / Dr. P. Nancharaiah. – Text: visual // IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2018; 17(2): 49-54. Doi:https://www.iosrjournals.org/iosr-jdms/papers/Vol17-issue2/Version-1/K1702014954.pdf

11. Olimxo F. X. et al. Liver micro-vessel features in postnatal ontogenesis //New day in medicine. – 2019. – №. 4. – C. 406-410.

12. Petro CC, et al. Central failures of lightweight monofilament polyester mesh causing hernia recurrence: a cautionary note. Hernia. 2015; 19 (1):155-159. Doi: https://link.springer.com/article/10.1007/s10029-014-1237-5

13. Rogers M. Prevention of incisional hernia after Aortic Aneurysm Repair [Text] / M. Rogers, R. McCarthy, J.J.Earnshaw // Eur J Vascular and Endovascular Surg. - 2003. – Vol. 26. – P.519-522.
Doi:https://www.sciencedirect.com/science/article/pii/S1078588403003836?via%3Dihub

14. Smoking is a risk factor for a hernia incision / L.T. Sorensen, U.B. Hemmingsen, L.T. Kirkeby [et al.]. // Arch Surg. 2005; 140(2): 119-123. Doi: https://jamanetwork.com/journals/jamasurgery/fullarticle/508337

15. Tursumetov A. A. et al. The Choice Of The Method Of Surgery For Combined Ulcers Of The Stomach And Duodenum //Solid State Technology. – 2020. – T. 63. – №. 6. – C. 15143-15153.