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Does the parastomal hernia rate depend on the method of stoma formation? (meta-analysis and review)

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ABSTRACT *AIM: to compare the effectiveness of different techniques for parastomal hernia prevention.*
MATERIALS AND METHODS: a systematic review and meta-analysis were performed in accordance with the PRISMA recommendations for the entire period up to 09/08/2023. The search for papers is carried out in PubMed with keywords "extraperitoneal", "transperitoneal", "intraperitoneal", "rectal cancer", "abdominoperineal resection", "parastomal hernia", "colostomy", "stoma", "end colostomy", "prophylactic mesh", "mesh". As a result of the literature selection, 28 studies were included in the meta-analysis — 15 studies for end colostomy with and without an implant; 5 studies comparing intra-abdominal and extraperitoneal end colostomy; 8 studies comparing stoma channels through the rectus abdominis shield (transrectal stoma) and lateral stoma.
RESULTS: the incidence of parastomal hernias is significantly lower for extraperitoneal stoma (p = 0.05) than intra-abdominal one (OR = 3.40, CI 1.01–11.44) without significant increase in postoperative morbidity rate (OR = 1.04, CI 0.53–2.02, p = 0.92, OR = 2.22, CI 0.67–7.30, p = 0.19). Mesh significantly decreases the incidence of parastomal hernias (OR = 1.87, CI 1.16–3.01, p < 0.0001) without a consistent increase in postoperative morbidity rate (OR = 0.93, CI 0.47–1.82, p = 0.82). No significant differences were obtained between lateral and transrectal colostomies in the incidence of parastomal hernia (OR = 1.14, CI 0.52–2.52, p = 0.74).
CONCLUSION: the extraperitoneal colostomy and meshes reduce the risk of parastomal hernia.

KEYWORDS: *end colostomy, parastomal hernia, complicated stoma*

CONFLICT OF INTEREST: *the authors declare no conflict of interest*

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INTRODUCTION

Despite the successes of colorectal surgery, the stoma ratedoes not tend to decrease. It is difficult to determine precise the number of such patients. Nevertheless, it is estimated that at least 120,000 stoma patients live in Russia [1], 100,000 in Germany [2], and at least 700,000 ones in the United States, with about 100,000 surgical procedures performed annually to form stomata [3]. Patients with permanent stomata account for 30% of these [4]. Stoma is a significant problem for patient. However, the possibilities for their adaptation have changed dramatically for the better in recent decades. Thus, a set of organizational measures, the creation of a rehabilitation service for stoma patients, psychological support and improvement of stoma care facilities made it possible to achieve good indicators of social rehabilitation and work activity [4].

However, this applies mostly to uncomplicated stomas. One or more early postoperative morbidities occur in 63% of patients [5], and late ones occur in 81.1% [6]. According to the Swedish randomized trial Stoma-Const, among patients who underwent elective surgery, late morbidityrate of end colostomy was detected in 63% of patients in a year after surgery [7]. It should be noted that this indicator does not significantly differ from the data for previous decades — 70% [8], despite the improvement in surgical instruments, preoperative marking, careful observance of surgical techniques

and the use of special preventive measures. Extrapolating these data to the total number of patients with intestinal stoma, it can be stated with great confidence that in many countries, including those with a high level of development of colorectal surgery, there are tens of thousands of patients with parastomal hernias and a low probability of medical and social rehabilitation.

At least 30% of patients with parastomal hernias require surgical treatment, while the success of such procedures is often questionable, and the risk is higher than in end-colostomy procedures after Hartmann's surgery [9]. In this regard, the prevention of parastomal hernias is a question of the first line.

Specialists have been concerned about this issue since almost the first steps in the development of coloproctology as a surgical subsprcialty. So, in 1958, Goligher J.C. proposed mesh end colostomy [10]. This method is still used today, making it possible to reduce the rate of parastomal hernias to 1.0–6.5%[11–13].

At the same time, the meshend colostomy is associated with a number of limitations and problems. The method requires additional mobilization of the colon segment up to the left flexure for its free removal to the anterior abdominal wall, which increases the operation time and surgical trauma, while increasing the risk of colon ischemia in mesh segment. In addition, there is a risk of strangulation and compression of the bowel in the mesh stoma canal, which also increases the risk of bowel obstruction. Significant technical difficulties arise with short mesentery, visceral obesity, impaired intestinal function, and surgical site infection. Due to the above mentioned, the mesh permanent end stoma has not become the method of choice.

In 1980, Sugarbaker P. proposed the use of an intraperitoneal mesh to enforce the anterior abdominal wall at the stoma site for the prevention of parastomal hernia [14]. This method was based on the same philosophy as the mesh method of Goligher. In this case, Sugarbaker's method is easier and has a number of advantages: there is no need for additional mobilization of the proximal segment for removal to the anterior abdominal wall, there is no need to blindly form the stomal canal, increasing the traumasurgery-traumaand the risk of postoperative complications, etc. The method was received with great enthusiasm and has been widely used since the mid-1990s, when affordable and relatively cheap meshes became available. As experience gained, it became obvious that this approach is associated with a number of specific postoperative complications and may not be used in all patients.

Since then, numerous modifications of the method have been proposed, new models of meshes made of new materials and methods of their placement in the anterior abdominal wall have been developed, but so far, the effectiveness of the method has not been confirmed, and the rate of parastomal hernias was 55.6% [15].

In 1982, Eldrup J., et al. drew attention to the fact that almost everywhere the intestinal stoma was removed to the anterior abdominal wall either in the thinnest site, along the semilunar line, or even more laterally, crossing the fibers of the lateral abdominal muscles, which was regarded as a construction failure. As a solution to the problem, the authors proposed to remove the intestine to the anterior abdominal wall through the thickness of the rectus abdominis muscle, thereby creating an elastic framework for the bowel in the stomal canal [16]. The method quickly gained popularity and is currently the method of choice in most clinics in Europe, although its effectiveness has not been confirmed to date [17].

These are the three main areas of scientific search for the prevention of parastomal hernias. New modifications of known methods are constantly being proposed and attempts are being made to substantiate their effectiveness. In addition to the objective organizational and methodological complexities, as well as significant variability in conceptual approaches, the results of such studies need to be assessed in details, which was the aim of this study.

MATERIALS AND METHODS

The systematic review and meta-analysis were performed in accordance with the practice and recommendations of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) [18]. The literature search was made using the electronic database of medical literature Medline, for the entire period until August 9, 2023. Query keywords were as follows: mesh, transperitoneal, intraperitoneal, rectal cancer, abdominoperineal resection, parastomal hernia, colostomy, stoma, end colostomy, prophylactic mesh, mesh. Animal studies were excluded from the inquiry. Additionally, a literary search was based on the bibliographic data of selected studies in order to identify missing articles during the initial search. The systematic review and meta-analysis included full-text papers in English.

Statistical Analysis

Statistical analysis with a direct comparison of methods was performed using the Review Manager 5.3 program. The total value of the dichotomous data is described as an odds ratio (OR) with a 95% coincidence interval (CI). OR was calculated using Peto's method if one of the values of the two-field table was 0. Statistical heterogeneity among studies was assessed using the χ^2 test.

Statistically significant heterogeneity was considered to be $I^2 > 50\%$ and $p < 0.1$.

Search Results

After making a PubMed query, 276 papers were found in the Medline database (Fig. 1). After screening, 67 full-text articles remained. At the next stage, literature reviews and clinical cases were excluded.

Additionally, a search was performed among the selected articles for analysis in the literature lists, which allowed us to identify 5 more studies. As a result, the analysis included 28 articles comparing techniques for the formation of end colostomy. Of these, 15 studies comparing the formation of a stoma with and without anmesh; 5 studies comparing intraperitoneal and extraperitoneal stomas.; 8 studies comparing the formation of the stomal canal through the thickness of the rectus abdominis muscle (transrectally) and laterally (pararectally). Given the small number of studies on lateral and transrectal stoma formation, the analysis also included studies with ileostomas.

Data Acquisition

The data of interest from the studies included in the analysis were: author, year of publication, study design, number of patients in groups (stoma with and without mesh, intraperitoneal and extraperitoneal stoma, method of formation of the stomal canal: transrectal and pararectal), the ratio of males to females in groups, age, early results.

Inclusion and Exclusion Criteria

Inclusion criteria in the analysis are intestinal stoma performed using one of the above methods. Exclusion criterion is duplication of data by authors.

Quality of Studies

All the studies were analyzed using the Newcastle — Ottawa Score (NOS) quality assessment system (Tables 1,2,3). The quality rating was

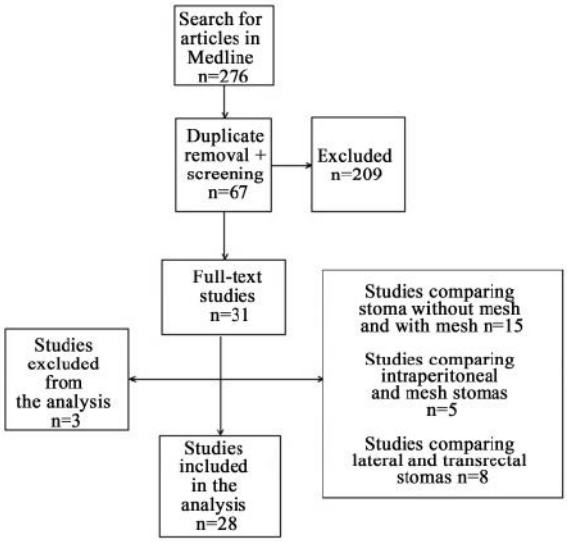

Figure 1. *Flow diagram of the systematic literature search and study selection according to PRISMA statement*

Table 1. *Characteristics of the included studies: mesh vs no mesh for end colostomies*

Author	Year	Period of time	Country	Study type	Quality scale	N		Gender M/F	
						Without an mesh	With an mesh	Without an mesh	With an mesh
Hammond et al [19]	2008	no data	England	Rand.	7	10	10	no data	no data
Serra-Aracil et al [20]	2009	2004–2006	Spain	Rand.	8	27	27	no data	no data
Janes et al [21]	2008	2001–2003	Sweden	Rand.	8	27	27	16/11	15/12
Ventham et al [22]	2012	2003–2010	England	retro	8	24	17	13/11	3/14
Lopez-Cano et al [23]	2012	2007–2010	Spain	Rand.	9	17	19	7/10	11/8
Tarcoveanu et al [24]	2014	2010–2011	Romania	Rand.	7	22	20	no data	no data
Fleshman et al [25]	2014	2010–2012	USA	Rand.	9	58	55	29/29	30/25
Nikberg et al [26]	2015	1996–2012	Sweden	Prosp.	7	135	71	84/51	43/28
Lambrecht et al [27]	2015	2007–2011	Norway	Rand.	8	26	32	21/5	22/10
Vierimaa et al [28]	2015	2010–2013	Finland	Rand.	9	35	35	19/16	18/17
Brandsma et al [29]	2016	2010–2012	Netherlands	Rand.	8	78	72	48/28	43/29
Lopez-Cano et al [30]	2016	2012–2014	Spain	Rand.	8	28	24	16/8	21/3
Odensten et al [31]	2019	2007–2015	Sweden	Rand.	8	118	114	62/56	74/40
Prudhomme et al [32]	2021	2012–2016	France	Rand.	8	101	98	57/44	57/41
Ringblom et al [33]	2023	2007–2015	Sweden	Rand.	8	118	114	62/56	74/40

Table 2. *Characteristics of the included studies: intraperitoneal vs extraperitoneal end colostomies*

Author	Year	Period of time	Country	Study type	Quality scale	N		Gender M/F	
						Intraper-itoneal	Extraper-itoneal	Intraper-itoneal	Extraper-itoneal
Whittaker et al [34]	1975	no data	England	Prosp.	5	162	89	no data	no data
Dong et al [35]	2012	2002–2010	China	Rand.	7	62	66	29/33	30/36
Hamada et al [36]	2012	2005–2010	Japan	Ретро Retro.	7	15	22	13/2	11/11
Leroy et al [37]	2012	1999–2011	France	Retro.	8	10	12	6/4	8/4
Heiying et al [38]	2014	2011–2012	China	Rand.	7	18	18	7/11	9/9

Table 3. *Characteristics of the included studies: transrectal vs lateral stomas*

Author	Year	Period of time	Country	Study-type	Quality scale	N		GenderM/F	
						Pararec-tal	Transrec-tal	Pararec-tal	Transrec-tal
Sjodahl et al [39]	1988	1988	England	Retro.	5	23	107	no data	no data
Williams et al [40,41]	1990	1972–1987	England	Prosp.	5	16	12	no data	no data
Ortiz et al [42]	1993	н/д	Spain	Prosp.	5	29	25	no data	no data
Leong et al [43]	1994	1994	England	Retro.	5	42	103	no data	no data
Londono-Schimmer et al [44]	1994	1994	England	Retro.	5	31	72	no data	no data
Cingi et al [45]	2006	2000–2005	Turkey	Prosp.	6	6	14	no data	no data
Pilgrim et al [46]	2010	2004–2006	Australia	Prosp.	6	10	80	no data	no data
Hardt et al [47]	2015	2012–2014	Germany	Rand.	7	30	30	14/16	19/11

determined for each study. A high-quality study is considered to have a rate of 7 out of 9 stars.

RESULTS

The operation time was significantly shorter for extraperitoneal stoma ($p < 0.00001$) vsintraperitoneal (Fig. 2) (OR = 9.06, CI 7.72–10.41).

The rate of parastomal hernias was significantly lower with extraperitoneal stoma ($p = 0.05$) compared with intraperitoneal (OR = 3.40, CI 1.01–11.44) (Fig. 3).

The postoperative hospitalstay (Fig. 4) was significantly shorter ($p = 0.02$) in the group with extraperitoneal stoma (OR = 1.21, CI 0.17–2.24).

The postoperative morbidity rate (Fig. 5) in the groups with extraperitoneal and intraperitoneal stoma was comparable. (OR = 1.69, CI 0.55–5.17, $p = 0.35$).

According to the incidence of parastomal abscess (Fig. 6) and stoma prolapse (Fig. 7), there were no significant differences (OR = 1.04, CI 0.53–2.02, $p = 0.92$; OR = 2.22, CI 0.67–7.30, $p = 0.19$).

Comparison of Groups According to the Method of Stoma Formation: with and without mesh

The operation time for stoma with additional strengthening of the internal lumen of the stomal canal with a mesh was the same in the groups (OR = 14.59, CI = 0.77–29.94, $p = 0.06$), (Fig. 8).

The incidence of parastomal hernia (Fig. 9) was significantly lower in the mesh group (OR = 1.87, CI 1.16–3.01, $p < 0.0001$).

The total rate of early and late postoperative morbidity in the groups with and without anmesh did not significantly differ (OR = 1.20, CI 0.81–1.78, $p = 0.35$) (Fig. 10). There were also no significant differences in the postoperative surgical site infection rate (OR = 0.93, CI 0.47–1.82, $p = 0.82$).

In terms of the early parastomal morbidity rate, the groups were also comparable (OR = 1.04, CI 0.39–2.77, $p = 0.93$) (Fig. 11).

When comparing the groups with and without mesh, there were no significant differences in the

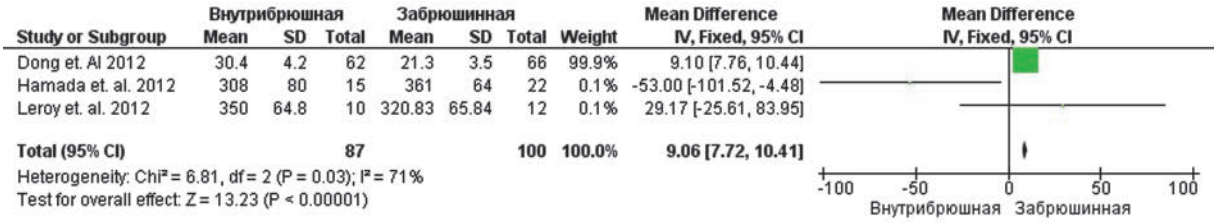

Figure 2. *Forest plot of operation time for extraperitoneal vs conventional end colostomy*

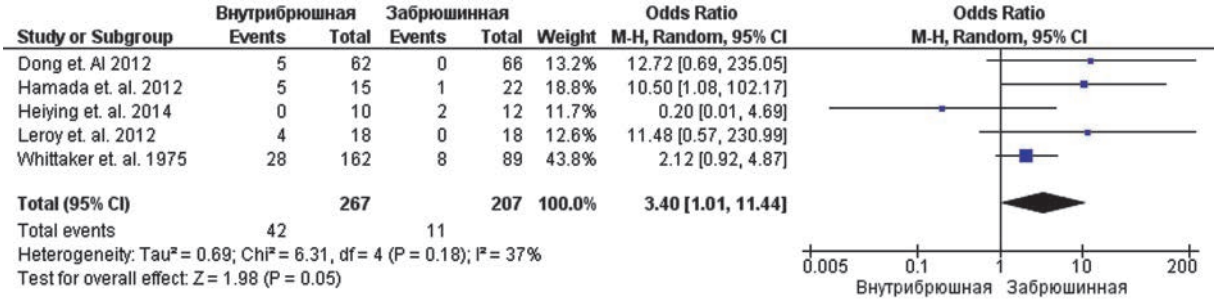

Figure 3. *Forest plot of parastomal hernia incidence for extraperitoneal vs conventional end colostomy*

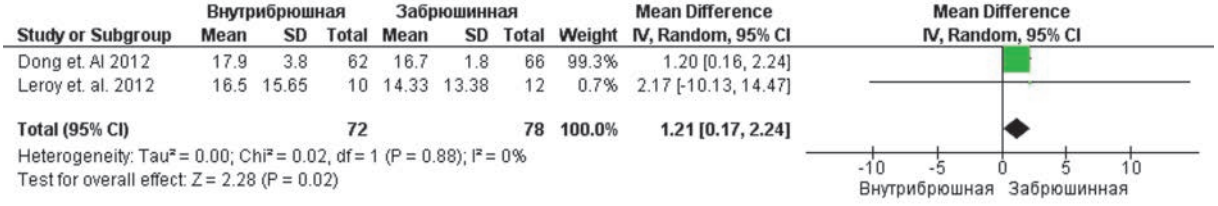

Figure 4. *Forest plot of hospital stay for extraperitoneal vs conventional end colostomy*

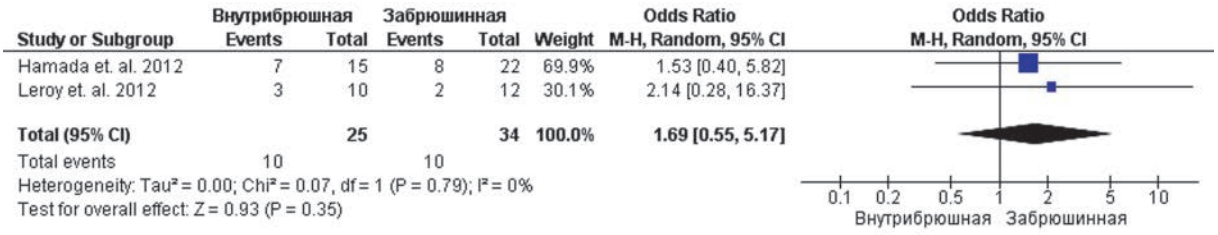

Figure 5. *Forest plot of postoperative morbidity for extraperitoneal vs conventional end colostomy*

incidence of stoma prolapse (OR = 2.35, CI 0.91–6.07, $p = 0.08$) (Fig. 12).

There were also no significant differences in the incidence of intestinal stoma stricture (Fig. 13) (OR = 0.66, CI 0.24–1.82, $p = 0.42$).

There were no significant differences in the incidence of parastomal abscess (Fig. 14), peristomal fistula (Fig. 15), and stoma necrosis (Fig. 16) when comparing the groups with and without mesh (OR = 0.96, CI 0.32–2.84, $p = 0.94$; OR = 1.02,

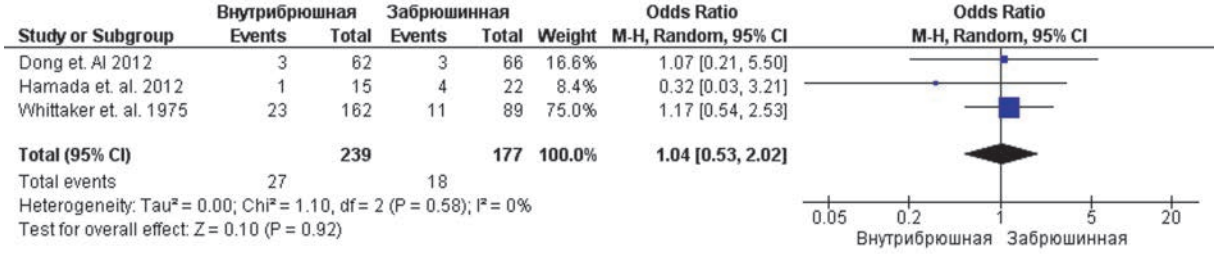

Figure 6. *Forest plot of parastomal abscess rate for extraperitoneal vs conventional end colostomy*

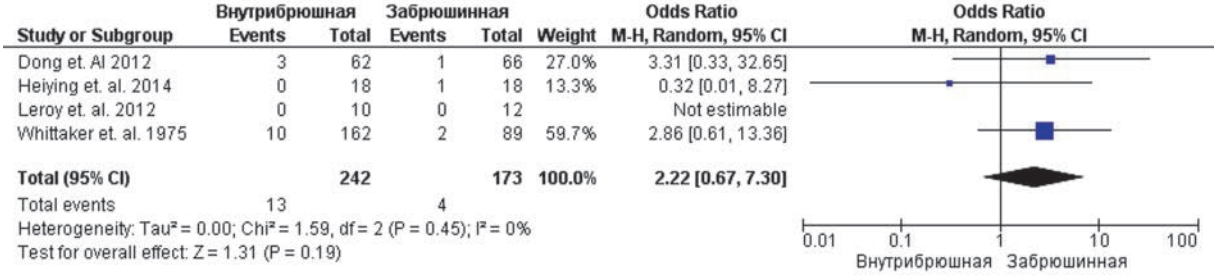

Figure 7. *Forest plot of stoma prolapse rate for extraperitoneal vs conventional end colostomy*

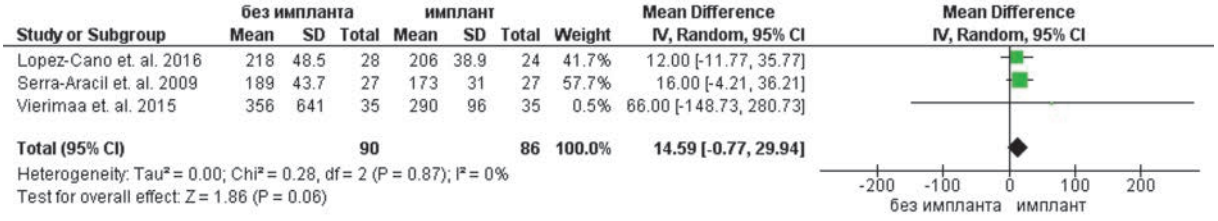

Figure 8. *Forest plot of operation time for mesh vs no mesh end colostomy*

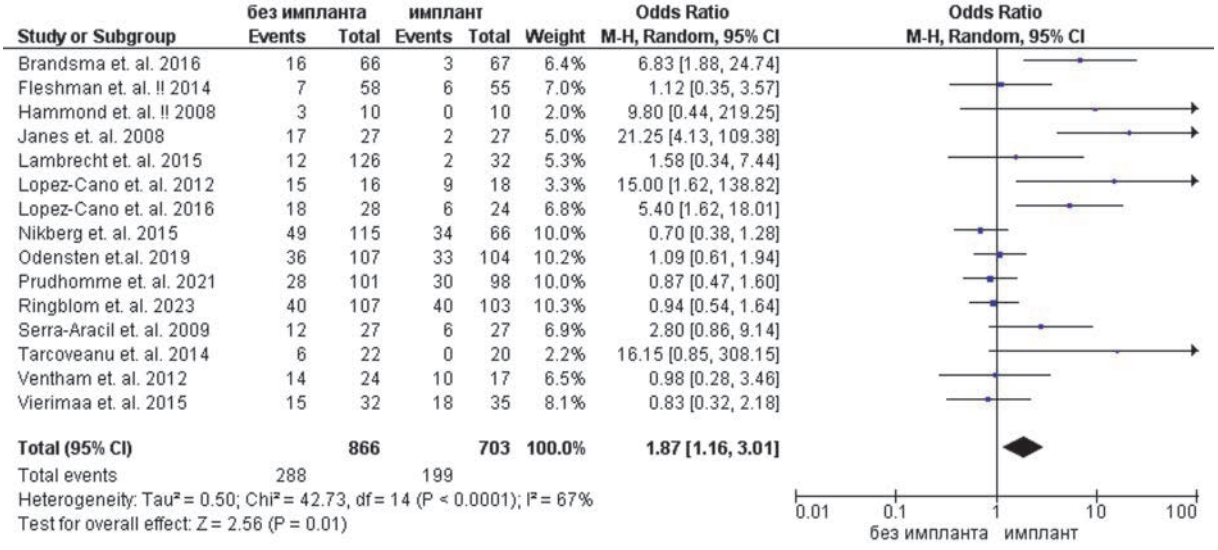

Figure 9. *Forest plot of parastomal hernia incidence for mesh vs no mesh end colostomy*

CI 0.10–10.58, p = 0.99; OR = 1.42, CI 0.57–3.56, p = 0.56).

Comparison of Groups Using the Method of Intraperitoneal Stoma by Transrectal and Pararectal Access

When comparing the groups according to the technique of forming the stomal canal by lateral and transrectal access (Fig. 17), no significant parastomal hernia rates were obtained (OR = 1.14, CI 0.52–2.52, p = 0.74).

DISCUSSION

Thisstudy has a number of limitations. First of all, this is an insufficient number of studies, which clearly does not correspond to the scope of the problem. The groups being compared are heterogeneous based on the main feature, namely, the variability of surgical methods. Nevertheless, the results obtained allow us to draw a number of significant conclusions.

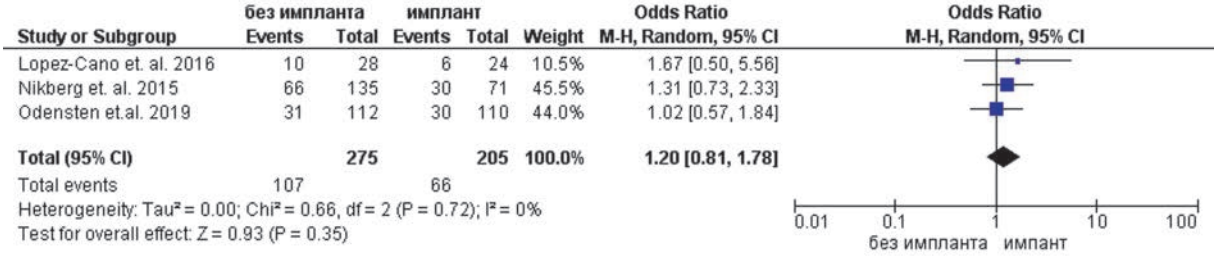

Figure 10. *Forest plot of all postoperative complications rate for mesh vs no mesh end colostomy*

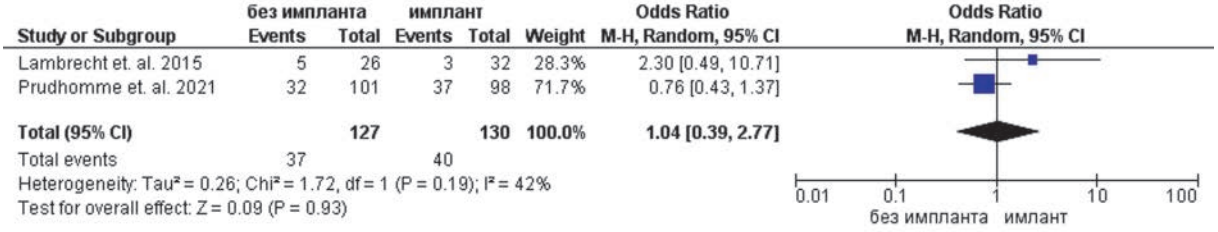

Figure 11. *Forest plot of early postoperative complications rate for mesh vs no mesh end colostomy*

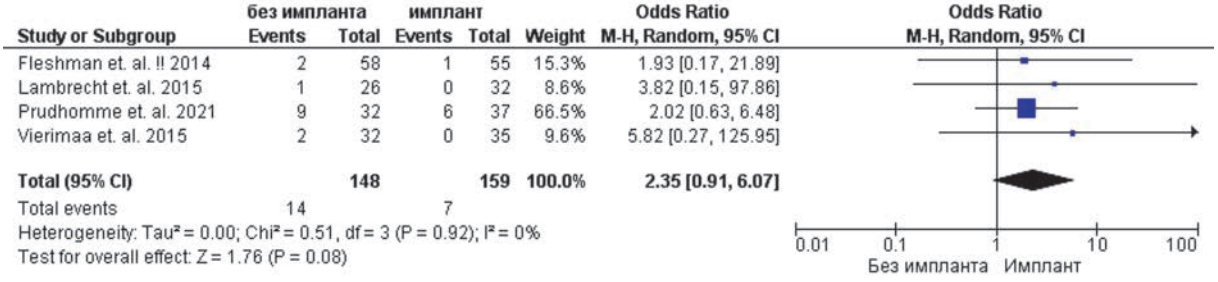

Figure 12. *Forest plot of stoma prolapse rate for mesh vs no mesh end colostomy*

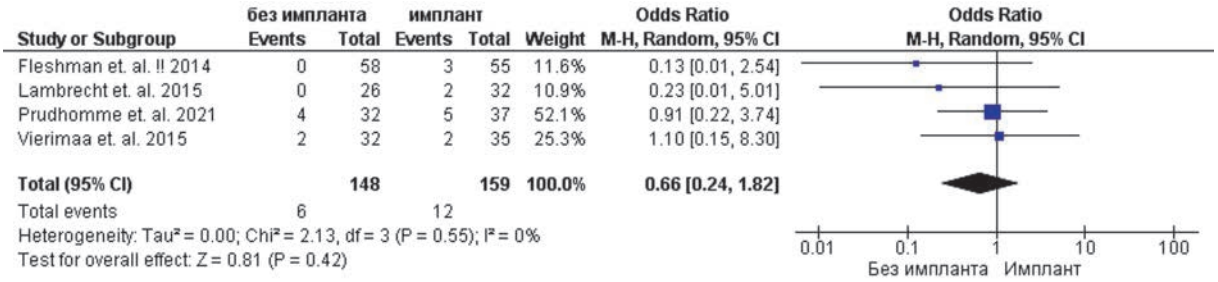

Figure 13. *Forest plot of stoma stenosis for mesh vs no mesh end colostomy*

It is impossible to consider and analyze the effectiveness of preventive measures to prevent parastomal hernias in isolation from the main links of their pathogenesis. Obviously, its key element is the need to form a through defect in the anterior abdominal wall for the intestine to pass through it. Thus, one of the methods of prevention is the mesh, which significantly reduces the incidence of parastomal hernias, which was confirmed in this meta-analysis. At the same time, there are differences in the technique of stomal canal formation in the compared groups. According to the classical method by Goligher J., it is suggested to create a stomal canal in the preperitoneal area, while still forming a through defect in the musculaponeurotic layer of the anterior abdominal wall and, as a rule, in its thinnest part, i.e. along the semilunar line. Thus, this method does not

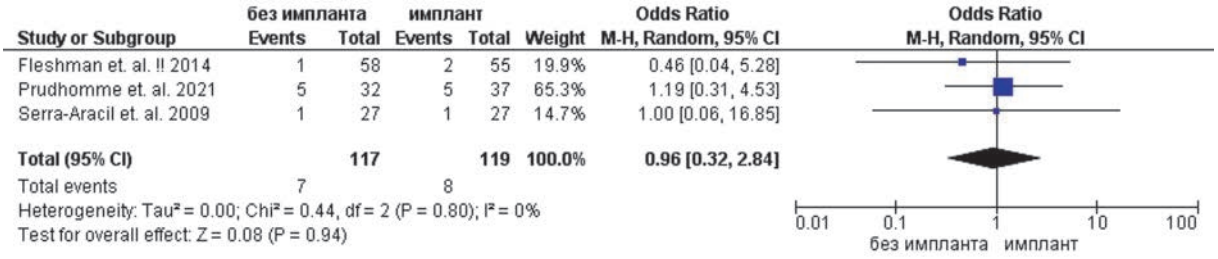

Figure 14. *Forest plot of parastomal abscess rate for mesh vs no mesh end colostomy*

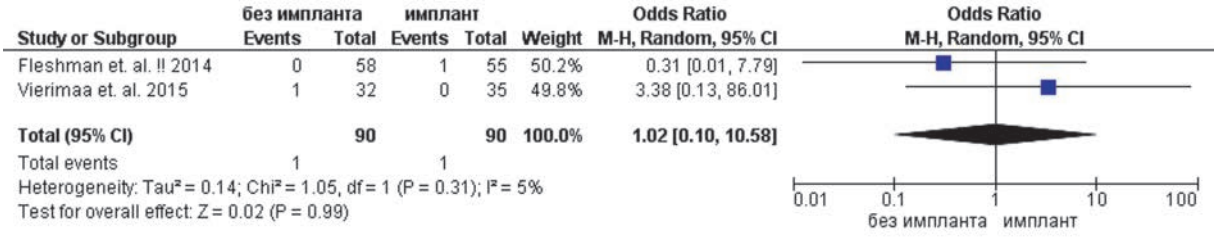

Figure 15. *Forest plot of parastomal fistula rate for mesh vs no mesh end colostomy*

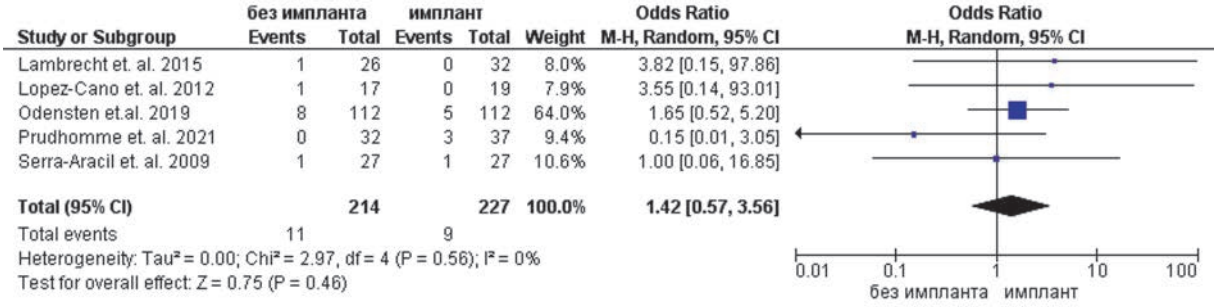

Figure 16. *Forest plot for stoma necrosis rate for mesh vs no mesh end colostomy*

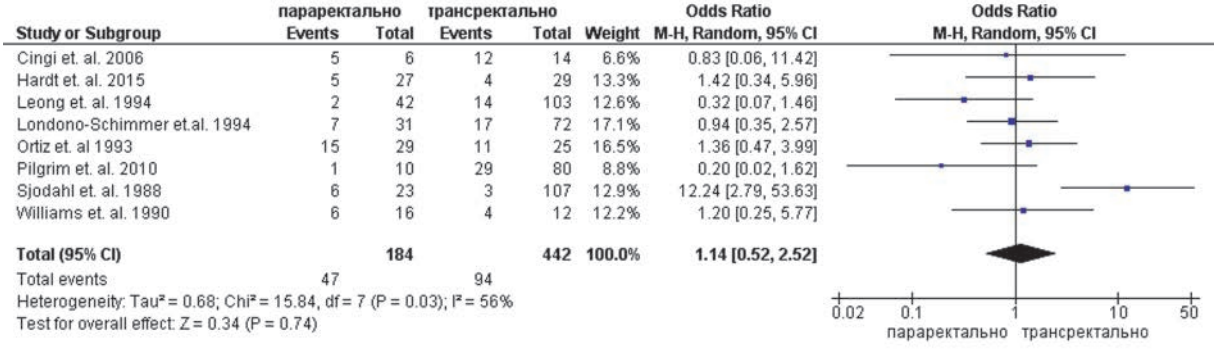

Figure 17. *Forest plot for parastomal hernia incidence for transrectal vs lateral stomas*

involve the elimination of the main risk factor for a parastomal hernia. Their incidence decreases, apparently, due to an increase in the length of the stomal canal and better fixation of the bowel with stoma in it, which practically eliminates stoma prolapse and false parastomal hernia, while true parastomal hernias still form, albeit much later and with a lower incidence. This type of procedure was performed in only 1 out of 5 studies included in this meta-analysis [34]. In 2005, Leroy J. proposed a technique that, during laparoscopic abdominal-perineal procedure, involves entering the preperitoneal area by dissecting the posterior sheath of the rectus aponeurosis at an oblique angle to the incision of the anterior sheath of the aponeurosis, closer to the lateral vaginal wall of the rectus muscle. In this way, a transrectal canal is formed, which forms an angle close to 90° [37]. Hamada M. realized this philosophy [36]. In the remaining 2 included studies, the authors realized various modifications of this method. Thus, Dong formed the stomal canal lateral to rectus abdominal muscle, stratifying the internal oblique and transverse muscles [35]. Heiying J. performed transrectal access, penetrated the area between the internal oblique and transverse muscles, dissected the peritoneum in the left lateral canal, and then sutured the muscle lesion together with the peritoneum after passing the bowel through it.

The results of the meta-analysis confirm the hypothesis that this method of mesh stoma significantly reduces the incidence of parastomal hernias and other parastomal morbidities. Nevertheless, in the studies by Dong, Hamada, and Leroy, the operation timewas longer in the comparison group, that is, during conventionalintraperitoneal colostomy. This can only be explained as an indirect sign of the heterogeneity of the compared groups, since in any case, the formation of the mesh canal and additional mobilization of the bowel increase the operation time, especially in patients with visceral type of obesity. Consequently, in the main group, the decrease in operation time occurred due to a reduction in the time of the main stage, namely abdominal perineal extirpation, which indicates the heterogeneity of the compared groups. Much more studies included in the meta-analysis are devoted to the use of meshes for the prevention of parastomal hernias. During the search for solutions to this problem, synthetic, organic, absorbable and non-absorbable meshes were used, and their position in the layers of the anterior abdominal wall also changed. Most authors use the location of the mesh in the area between the rectus abdominis and the posterior sheath rectus abdominis [20–22,25–27,31,33]. Other mesh placement options are in the layer between the peritoneum and the rectus abdominis [19,24,29,32] and intraperitonealmesh placement [23,28]. The incidence of parastomal hernias is significantly reduced, which is confirmed by the results of the meta-analysis ($p < 0.0001$). It should be noted that a more standardized approach is needed for widespread adoption of the method, which requires further study. The disadvantage of the method, in addition to differences in the technique of surgery and mesh materials, is the fact that the mesh is in close contact with the bowel wall. With a technically flawlessly performed surgery, this does not lead to early postoperative complications as ulceration, perforations, and fistulas. Problems arise at a later date, after 2 years or more: this is anbowel dysfunction which carries the stoma, and pain in the stoma area. In most included studies, the period of patient follow-up does not exceed 1 year. Unfortunately, there is also no data on the causes of the formation of parastomal hernias when using meshes, which would be extremely helpful for further scientific research.

The intraperitoneal stoma by lateral or transrectal access does not affect the incidence of parastomal hernia [42,45,47]. At the same time, it is of interest to see how effective transrectal access can be when using the mesh method of forming the stomal canal.

It should be noted that all studies share a common attitude topermanent end colostomy as a complex

reconstructive stage of surgery, which largely determines the quality of life of patients for many years, and not only by focusing on the outcome of treatment of the primary disease. It is also necessary to revise approaches to permanent colostomy from the point of view of the clinical anatomy of the anterior abdominal wall, which has been vividly demonstrated by modern studies in herniology. Such a paradigm shift will undoubtedly bring us closer to solve this problem.

CONCLUSION

The extraperitoneal permanent stoma and meshes significantly reduces the risk of parastomal hernias.

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