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Hiatal hernia surgery: laparoscopic versus robotic approach?

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Aim. Evaluate the advantages and disadvantages of laparoscopic and robot-assisted anti-reflux operations.
General findings. Reflux esophagitis in the association with hiatal hernia on the third place in the structure of gastroenterological diseases. The development of minimally invasive surgical technologies has led to an increase in the number of laparoscopic and robot-assisted anti-reflux operations. The literature review includes 12 studies, the results of which were published from 2002 to 2020, with a total number of patients 1633. In most of them, when comparing laparoscopic and robot-assisted anti-reflux operations, the advantages of one or another technique were not revealed. In some studies, the high cost and duration of the operation were noted when using the da Vinci robotic surgical complex. Other studies have reported possible improvements in the treatment outcomes of patients with large or recurrent hiatal hernias due to the high precision of movement and improved visualization characteristic of therobot-assisted surgeries.
Conclusion. It is necessary to conduct more researches on this problem to develop indications for the choice of a particular surgical approach, as well as to create a single transparent algorithm for the surgical treatment of patients with reflux esophagitis and hiatal hernia.
Keywords. Robot-assisted fundoplication, da Vinci robotic surgery, hiatal hernia, reflux esophagitis
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Хирургия грыж пищеводного отверстия диафрагмы: лапароскопические или робот-ассистированные операции?

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Цель: оценить преимущества и недостатки лапароскопических и робот-ассистированных антирефлюксных операций.
Основные положения. Рефлюкс-эзофагит на фоне грыжи пищеводного отверстия диафрагмы занимает третье место в структуре гастроэнтерологических заболеваний. Развитие малоинвазивных хирургических технологий привело к увеличению количества лапароскопических и робот-ассистированных антирефлюксных операций. В обзоре литературы рассматриваются 12 исследований, результаты которых были опубликованы с 2002 по 2020 г., с общим количеством пациентов 1633. В большинстве из них при сравнении лапароскопических и робот-ассистированных антирефлюксных операций не было выявлено преимуществ той или иной методики. В некоторых исследованиях были отмечены высокие стоимость и длительность операции при использовании роботизированного хирургического комплекса «da Vinci». В других исследованиях сообщается о возможном улучшении результатов лечения пациентов с большими и/или рецидивными грыжами пищеводного отверстия диафрагмы благодаря высокой точности движений и улучшенной визуализации, характерных для робот-ассистированных операций.
Заключение. Необходимо проведение дальнейших исследований данной проблемы для разработки показаний к выбору того или иного хирургического доступа, а также создание единого прозрачного алгоритма хирургического лечения пациентов с рефлюкс-эзофагитом и грыжей пищеводного отверстия диафрагмы.
Ключевые слова: робот-ассистированная фундопликация, роботизированный хирургический комплекс «da Vinci», грыжа пищеводного отверстия диафрагмы, рефлюкс-эзофагит
Конфликт интересов: авторы заявляют об отсутствии конфликта интересов.

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Introduction

The tactics of treating patients with hiatal hernia (HH) is one of the most significant problems in modern gastroenterology. According to a number of authors, HH is among the three most frequently diagnosed diseases of the gastrointestinal tract (GIT), behind only to cholelithiasis and stomach and duodenum ulcers in terms of prevalence [1, 2]. According to some authors, the prevalence of HH in the working population of developed countries ranges from 5 to 40 % and can reach 50–80 % in elderly patients [3, 4]. In half of the cases, HH can occur without clinical manifestations, but more than 90 % of these patients, over time, have complaints of typical symptoms of reflux esophagitis (RE), such as heartburn, belching, dysphagia or odynophagia [4].

RE is a disease caused by pathological flow back and long-term exposure of gastric and / or duodenal contents to the esophageal mucosa. The development of RE is promoted by disorders in the motor-evacuation function of the stomach, as well as a prolonged pressure decrease in the lower esophageal sphincter (below 5 mm Hg), associated with insufficiency of the valvular apparatus of the cardia. In most cases, these functional disorders may be due to the presence of HH, which is diagnosed in 80–90 % of patients with RE [5]. In patients with reflux esophagitis complicated by peptic stricture, esophageal ulcer or Barrett's esophagus, HH of various sizes is detected in almost 100 % of cases [6].

According to modern clinical guidelines, the treatment of RE begins with drug therapy [7]. Unfortunately, in 40 % of cases, conservative treatment is ineffective, and RE symptoms persist or progress [8]. At the same time, even among patients who have a positive effect of drug therapy, the risk of developing complications such as esophageal stricture, bleeding, and intestinal metaplasia of the esophageal epithelium remains [9]. The ineffectiveness of conservative treatment, as well as the development of complications, can be an indication for surgical treatment, which aims to repair HH, the anatomical substrate provoking the development of RE, and create an anti-reflux mechanism — a fundoplication cuff.

The first report on the surgical treatment of HH was the work of Soresi A.L., published in 1919 [10]. The operation he performed was aimed to bring down the organs located in the hernial sac into the abdominal cavity and suture the diaphragm with separate interrupted sutures. This operation gave rise to the first historical stage of HH surgery characterized by an anatomical approach to treatment. All surgeries of that time were aimed to reduce the size of the esophageal opening of the diaphragm and differed from each other only in the method of suturing.

The studies of Allison P.R. and Barrett N.R. had a significant role in understanding the interrelation between anatomical changes in the zone of cardia, disorders of physiological processes and morphological manifestations of the disease [10]. Both authors focused on the prevention of gastric contents flow back into the esophagus, considering it a key factor in the pathogenesis of RE. Allison P.R. pointed to the need for crororaphy, suggesting it as a way of preventing reflux, whereas Barrett N.R. expressed the need for restoring the acute angle of His. Thus, a new historical stage was laid in the treatment of HH and RE: anti-reflux surgery. So, the development of many surgical treatment methods aimed at both repairing the HH itself and preventing reflux (Lataste, Mustard, Boerema, Hill, Nissen, Toupe, Chernousov, etc.) gave rise to the logical advancement of this approach.

Modern approaches to the surgical treatment of HH and RE are based on the key principles of operations developed in the early and middle of the 20th century. Active introduction of modern endovideo-surgical technologies and minimization of the traumatic character of operations is the characteristic feature of this modern age. Bernard Dallemange was the pioneer of laparoscopic anti-reflux surgery who performed the first laparoscopic Nissen-Rossetti fundoplication in 1991 [11]. Over the next few years, it has been proven in practice that laparoscopic access is the method of choice for anti-reflux operations [12].

The introduction of the robotic surgical complex (RSC) "daVinci" (Intuitive Surgical Inc., Sunnyvale, California) logically followed up on the achievements of scientific and technological progress in surgery. In 2000, the agency of the US Department of Health and Human Services (Food and Drug Administration) gave permission for surgical interventions using the da Vinci RSC. Later in 2001, with the support of the University Medical Center (UMC) and the Arizona State University Department of Surgery, permission was granted for the first robot-assisted (RA) operation [13]. Since then, the number of surgical interventions performed with RSC has been progressively increasing every year [14]. To date, certain experience in RA anti-reflux operations has been gained and featured in the systematic review on the treatment of HH and RE [15]. Among domestic authors, there is still no consensus on access and indications for the use of RSC in HH and RE. Thus, in the draft national clinical guidelines for the treatment of HH, presented by the Russian Society of Surgeons, this issue remained uncovered. Thus, due to economic factors, as well as a small number of RSC in Russia, the issue of relevance of RA operations and the advantages over laparoscopic technologies for the surgical treatment of HH remains open.

In view of the above, it seems relevant to analyze domestic and world publications in order to assess the advantages and disadvantages of RA anti-reflux

operations, as well as to specify the indications for the use of RSC in patients with HH and RE.

Materials and methods

We have studied current foreign and domestic literature on the surgical treatment and the comparative analysis of HH and RE via laparoscopic access versus the use of da Vinci RSC. Our search for works on the topic of literature review was carried out in the following databases: Pubmed, Scopus, Google Scolar, Cyberleninka, eLibrary, DisserCat, ScienceDirect. The following key words were used: "laparoscopic fundoplication", "robot-assisted anti-reflux surgery", "daVinci", "hiatal hernia", "reflux esophagitis". Despite the urgency of the problem, we managed to find less than 20 publications satisfying the search queries (Table 1).

Resluts

In one of the first studies on anti-reflux RA operations, W. Scott Melvin points out to the safety and effectiveness of daVinci RSC use in the treatment of patients with reflux esophagitis [16]. Forty patients with RE were included in a prospective study, the results of which were published in 2002. The group of patients operated on by laparoscopic approach included 20 patients, 17 of them underwent Nissen fundoplication, three patients underwent Toupet procedure. The group undergoing RA surgeries was similar in terms of the number of patients and the ratio of surgical techniques used: n = 20, 17 and 3, respectively. The observation period of patients in the two groups averaged 11.2 and 6.7 months, respectively. The authors concluded that the two groups did not statistically differ in the level of perioperative complications, duration of hospitalization, number of relapses, while the total time of RA operations was on average 45 minutes longer than the laparoscopic ones. The authors say the difference in the duration of the procedures might be due to the adaptive stage of mastering the technique and point out to the need for additional research after passing the learning curve.

In further studies, similar results were obtained, which indicated that as compared with laparoscopic procedures, RA operations require more time with the same efficiency, the level of perioperative complications, the duration of hospitalization, and the need for reoperations [17–19]. At the same time, the difference in the total time of the operation was due to the duration of preparatory measures in the RA surgery group, and the time required to perform certain stages of the operation was matched to that of the laparoscopic approach. In some studies, the duration of the operation itself was shorter in the RA group of operations. Thus, Muller-Stich et al., comparing 2 groups of patients, 20 people in each, operated laparoscopically and with the use of RSC,

Table 1. Brief characteristics of publications included in the literature review

Study	Type of study	Groups of patients	Number of patients	Observation period
Melvin et. al., 2002	Prospective study	laparoscopic fundoplication robot-assisted fundoplication	20 20	11.2 months 6.7 months
Draaisma et. al., 2006	Randomized controlled trial	laparoscopic fundoplication robot-assisted fundoplication	25 25	6 months 6 months
Morino et. al., 2006	Randomized controlled trial	laparoscopic fundoplication robot-assisted fundoplication	25 25	22.3 months 22.3 months
Nakadi et. al., 2006	Randomized controlled trial	laparoscopic fundoplication robot-assisted fundoplication	11 9	12 months 12 months
Muller-Stich et. al., 2007	Randomized controlled trial	laparoscopic fundoplication robot-assisted fundoplication	20 20	1 month 1 month
Brenkman et. al., 2016	Retrospective study	robot-assisted fundoplication	40	11 months
Soliman et. al., 2020	Retrospective study	laparoscopic fundoplication robot-assisted fundoplication	151 142	1 month 1 month
Gerull et. al., 2020	Prospective study	robot-assisted fundoplication	233	60 months
Tolboom et. al., 2016	Retrospective study	laparoscopic fundoplication robot-assisted fundoplication	30 45	10 months 3 months
O'Connor et. al., 2020	Retrospective study	laparoscopic fundoplication robot-assisted fundoplication	278 114	23.7 months 15.1 months
Semenyakin et al., 2019	Retrospective study	laparoscopic fundoplication robot-assisted fundoplication	291 72	Less than 1 month
Vetshev et al., 2019	Retrospective study	robot-assisted fundoplication	37	6 months

point out that under certain conditions, the speed of performing RA surgery increases significantly [21]. According to their data, the average duration of the operation via RSC was 88 minutes versus 102 minutes in the laparoscopy group. The authors state that RSC has a number of advantages that allow accelerating the mobilization of the stomach and esophagus in the region of the esophageal opening and facilitating the formation of the fundoplication cuff. In addition, during the study, a decrease in docking time (docking of the patient console) was noted as staff gained experience.

In a number of works, the authors studied the quality of life of patients after RA and laparoscopic anti-reflux operations. Draaisma et al. compared 2 groups of patients who underwent laparoscopic (n = 25) and robotic (n = 25) Nissen fundoplication [18]. Intra- and postoperative complications were not revealed in either group. RA operations required significantly more time and higher economic costs. When assessing the quality of life according to the GORD-HRQQL scale in 1, 3, 6 and 12 months after surgical treatment, no significant differences were found between the two groups ($p < 0.05$). Nakadi et al., in their study, came to similar conclusions about the longer duration and cost of RA anti-reflux operations [20]. Unfortunately, there were no reports on the methods of assessing the quality of life. At the same time, the authors reported that in the RA surgery group (n = 9), 4 patients had subjective complaints (dysphagia, epigastric pain syndrome, flatulence) in the 3rd month of observation, while in the laparoscopic group (n = 11) no complaints were recorded. By the 12th month of the follow-up, patients in both groups subjectively felt well, no reoperations were required. The authors of these two papers conclude that the benefits of RSC in anti-reflux surgery are not clear and thus do not recommend the routine use of the technology. At the same time, the researchers discuss the need for further study of RA anti-reflux interventions.

The urgency of the problem is demonstrated by publications based on the studies carried out in the 2000s. They are characterized by a small number of observations and the studies include predominantly small size HH cases. The most representative and statistically significant of them were included in systematic reviews and meta-analyses [22, 23]. So, in 2010, a team of authors, headed by S. R. Markar, conducted a meta-analysis, which included a total of 226 patients with RE who underwent RA and laparoscopic Nissen fundoplications [22]. When comparing the two methods, the researchers made assessments based on various factors, such as the presence or absence of relapses, the need for reoperation, development of dysphagia, fatal outcomes, operation time, duration of hospitalization, intraoperative and early postoperative complications and the total cost of the operation. The authors identified 6 randomized trials that met the search criteria. There were no deaths among the patients during the observation. There was no significant difference in the incidence of intraoperative complications (p = 0.202), as well as in the duration of hospitalization (p = 0.327) for the two groups. Having compared the average cost of the operation according to the available estimation data, the researchers concluded that the average cost of the operation is higher in case of RSC procedures. Three studies reported on the development of postoperative dysphagia, with no statistically significant difference between robotic and laparoscopic approaches (p = 0.902). In all the cases, the operation time via laparoscopic access was significantly shorter (p = 0.0002). At the same time, five studies had sufficient data on hospital stay, which was not statistically different between the two groups (p = 0.327).

The authors of the meta-analysis pointed out that the advantages of RA operations include factors, such as high accuracy and freedom of movement of instruments during manipulations, good ergonomics of the surgeon's workplace, clear imaging of anatomical structures, thus ensuring high precision during the work with tissues. The authors concluded that RA surgery has no clear advantages over laparoscopy, except in the "high-risk" category of patients. In their opinion, the use of RSC is appropriate in patients with altered anatomy due to previous operations for safer work in the conditions of the adhesion process in the abdominal cavity. In conclusion, the authors state the need for further large-scale studies of the problem in order to obtain a more reliable evidence base.

The research of the next decade was characterized by an increase in data and the inclusion of patients with large and/or recurrent HH. In many of them, encouraging results were obtained, indicating the benefits of RA operations in these categories of patients. Brenkman et al. retrospectively analyzed the treatment results of 40 patients who underwent Toupet RA fundoplication between July 2011 and March 2015 [24]. Most patients had paraesophageal HH, and more than 50 % of the stomach was located in the hernial sac. The average operation time was 118 minutes, the average blood loss was 20 ml. Six (15 %) patients had postoperative complications: two patients had suppuration of postoperative wounds, the other four were diagnosed with atelectasis of the lung, trocar hernia, mediastinitis, cecal perforation. The average length of stay in the hospital was 3 days. At the mid-point follow-up in the 11th month, 1 patient (2.5 %) had a clinical relapse of the disease, confirmed by X-ray data. The authors concluded that robot-assisted surgery was effective in the treatment of patients with subtotal and total HH with a relatively low rate of mid-term relapses. In their opinion, RSC provides advantages over laparoscopy during the isolation of the hernial sac and manipulations in a narrow anatomical space.

A possible advantage of RA approach in anti-reflux surgery may be the reduction of perioperative

complications in patients with large HH. Soliman B.G. et al., carried out a retrospective comparative analysis of treatment results in 293 patients from 2012 to 2017 [25]. RA operations were performed in 142 patients, 151 underwent laparoscopic procedures. In 70 % of cases, patients had type III or type IV HH. The authors revealed a decrease in the incidence of postoperative complications via RSC — 6.3 % versus 19.2 %, with laparoscopic access.

Most of these complications were due to damage to the thoracic cavity structures with the development of pneumothorax, pneumonia, which made it difficult to perform direct manipulations with instruments in the close proximity of the pleura using two-dimensional imaging, and, as a result, an increase in the duration of hospitalization in the group of laparoscopic operations (1.8 vs. 1.3 days). This study may indicate the benefits of RSC in terms of minimizing complications in the early postoperative period.

American surgeons headed by William D. Gerull conducted the largest prospective study we found, which included 233 patients with paraesophageal HH operated between 2010 and 2014 [26]. Patients younger than 18 years of age and/or those diagnosed with type I HH according to the current anatomical classification used in Europe and the USA were not included in the study. All the operations were performed using the da Vinci RSC. The patients with possible adequate esophageal mobilization underwent a Nissen fundoplication, and a Toupet fundoplication was performed in patients if a complete mobilization was impossible.

The results of the treatment were evaluated one month, 1, 3 and 5 years after the operation. All the patients were offered quality of life questionnaires (GERD-HRQL) at all the mentioned time points. At each patient visit, an X-ray examination of the esophagus was performed to assess the position of the fundoplication cuff. Its location above 2 cm above the level of the diaphragm was estimated as a radiological sign of a relapse. The surgeons assessed the operation time, the need for access conversion or esophageal lengthening (Collis operation), the volume of blood loss, the need for reoperation within 30 days after the initial intervention and mortality rates.

Of all 223 people, 62 % of patients underwent complete follow-up for 5 years, the rest of the patients were out of contact or lost touch. According to the authors, only one patient in the total number required esophageal lengthening surgery. The researchers also report that there were no access conversions, and the level of intraoperative blood loss did not exceed 35 ml. The time of surgical intervention averaged 183 minutes. Only one patient required reoperation within 30 days after the surgery. During the 5-year follow-up period, two more patients were reoperated due to HH and/or RE relapses.

According to the results of the quality of life assessment, 91 % of the operated patients were satisfied with the treatment and noted regression of the clinical manifestations of HH and RE. The respondents reported on 10-fold reduction in episodes of proton pump inhibitors.

The team of the authors describe the benefits of using RSC in anti-reflux surgery. In their opinion, RSC instruments facilitate access to anatomical structures and minimize the technical difficulties that a surgeon may encounter during classical laparoscopy. In particular, RSC facilitates access to the posterior mediastinum and minimizes the risk of trauma to the mediastinal pleura during mobilization of the cardia and hernial sac when working in a limited anatomical space, due to the longer length and 7 degrees of freedom of robotic instruments compared to traditional laparoscopic ones.

These factors also make it possible to work with greater safety in the conditions of the cicatricial process, minimizing the risks of damage to vital structures and organ perforation. In addition, the authors emphasize the minimized rates of access conversion when using RSC, compared to standard laparoscopy. Thus, based on the results of 5 years of work, the team of authors came to the conclusion that the use of RSC is a promising safe option in the treatment of RE associated with HH and can also lead to a significant and long-term reduction of recurrences and improve the quality of life of patients.

Patients with recurrent HH is an important problem of modern anti-reflux surgery. This category of patients was studied by Tolboom et al., who analyzed the results of RA operations in patients with recurrent HH [27]. The authors observed 75 patients who had previously undergone anti-reflux operations and required repeated surgical treatment due to clinical deterioration (relapse and increase in heartburn, dysphagia, etc.). Patients were divided into two groups: those who underwent laparoscopic and robot-assisted operations (30 and 45 people, respectively). Toupet fundoplication was the most frequently performed procedure (45 of 75 patients), Dor fundoplication was performed in 14 patients, and 10 patients underwent Nissen fundoplication. In 3 cases, the removal of the previously created cuff was not formed again. A mesh implant in the area of the esophageal opening was installed in 27 out of 45 patients during RA operations, while during laparoscopic surgeries, it was installed in 8 patients out of 30.

The impossibility of safe continuation of the surgical intervention and the need for access conversion was associated with the difficulty of identifying the anatomical structures and appropriate adhesiolysis during laparoscopy and, as a result, led to perforation of the organ wall, damage to large vessels causing bleeding, pleural defects, etc. In the RSC group of patients there were significantly fewer conversions than in the laparoscopy group (1 out of 45 patients versus 5 out of 30 patients).

When comparing intraoperative blood loss and the time spent both for different stages of the

operation and for the entire intervention, there was no significant difference between the first and second groups. There were no in-hospital or early postoperative deaths in either group. The time of hospital stay in the RA group was significantly less than in the laparoscopic group (2–3 days versus 3–7 days).

The follow-up time was 10 months for the group of patients operated on laparoscopically and 3 months for the group of RA operations. More than half of the patients in both groups had no or minimal complaints after surgical treatment and were easily adjusted by drug therapy.

The authors believe that, despite the absence of an obvious superiority of RSC over the laparoscopic approach, the use of RSC allowed to reduce the number of intraoperative complications, including those leading to access conversion, due to the high precision of manipulations in a limited space. Similar conclusions were made about patients who had previously undergone open surgery, for whom the option with the use of RSC turned out to be more comfortable. They pointed out the possibility of delicate dissection of cicatricial adhesions and suturing in a relatively small limited space due to instruments that can imitate the movement of a surgeon's wrist and have a large number of degrees of freedom.

In another study involving the category of patients with recurrent HH, the results of laparoscopic and RA anti-reflux operations were presented with a mid-point follow-up of more than 1 year. O'Connor et al. retrospectively compared 2 groups of patients matched in age, body mass index, perioperative risk, and comorbidities [28]. One group included 114 patients who were operated on for paraesophageal HH using RSC. The operation was repeated in 24.5 % of the patients. The traditional laparoscopy group included 278 patients, and only 12.9 % of them had been operated on earlier. The researchers did not find significant differences in the duration of the operation (179 minutes vs. 175 minutes), the level of perioperative complications, the need for reoperations and hospitalization. However, when followed up for 1 year or more, the frequency of radiological relapses in the RA surgery group was significantly lower (13.3 % vs. 32.8 %). At the same time, the researchers themselves point out that the median follow-up in this group was less (15.1 months versus 23.7 months in the laparoscopy group). Thus, the authors conclude that the use of robotic technologies in patients with paraesophageal HH has technical advantages compared to traditional laparoscopy and provides similar efficiency. The improved imaging, motion accuracy, and precise dissection associated with RA surgeries play an important role in HH reoperations, thus leading to reduced recurrence rates.

The technical advantages of robotic surgery in anti-reflux operations can also be found in the domestic literature. Semenyakin I.V. et al., conducted a study that included 363 patients with various degrees of RE severity associated with hiatal hernia [29]. All the patients underwent a Nissen fundoplication. In 291 cases, a laparoscopic approach was chosen, 72 patients were operated on using the daVinci RSC. The technique of surgical intervention did not differ in either the first or second group, except for the docking stage, which took no longer than 10 minutes and was not taken into account in the calculation of the total intervention time. The authors compared the intraoperative blood loss, the time of operation and early postoperative complications.

According to the results of the study, no advantages of this or that technique were revealed with certainty. However, the authors came to the conclusion that using RSC is a better choice for repeated interventions in conditions of acute adhesive process, since the accuracy of work in a 3D image, tremor leveling of the surgeon's hands ensure the precision of the surgical technique and minimize the risk of intraoperative complications. Another promising vision, according to the researchers, is the use of RSC in giant HH, when appropriate mobilization of the stomach is necessary in a limited space — in the posterior mediastinum. In addition to this, Semenyakin I.V. et al. point out to a significantly lower number of access conversions, as well as a decrease in the time of hospital stay after robot-assisted operations.

Another domestic work carried out by a team of authors of N.N. Burdenko Clinic of Faculty Surgery No. 1 of Sechenov University describes the treatment of 37 patients conducted in the period from 2015 to 2018. All the patients had giant HH and complicated reflux esophagitis and underwent RSC surgeries [30]. 60 % of the patients had typical manifestations of RE, 11 patients with total and subtotal HH had grade II-III dysphagia. All the patients underwent fundoplication modified by A.F. Chernousov, which was supplemented with anterior or posterior crororaphy, without implantation of mesh endoprostheses. There were no access conversions, intraoperative blood loss did not exceed 30 ml. There were no recurrences in either the early and late (more than 6 months) postoperative periods. The control endoscopic examination showed regression and / or absence of inflammatory changes in the esophageal mucosa in almost 100 % of the patients.

The authors came to the conclusion that the use of RSC provides high precision of manipulations due to a 10-fold magnified 3D image of the surgical field, the convenience of intracorporeal suturing, mobilization of the stomach and hernial sac in the posterior mediastinum via the "EndoWrist" technology. Despite the described advantages, the researchers do not point out to a fundamental difference in the stages of the operation, however, they recommend using RSC for large HH.

Conclusion

Despite the ambivalence of the results of the analyzed studied, in general, there is a consensus among

the authors that the use of RSC in the treatment of RE associated with HH provides a number of advantages over laparoscopic access. However, they all point out that these benefits are most useful when working with large and giant HHs, as well as in conditions of adhesions and / or scarring. In routine surgical practice, the use of RSC is not always justified [16–21]. The widespread introduction of RSC is a logical and extremely promising vision in the development of minimally invasive surgery.

Thus, during laparoscopy, the surgeon is limited in degrees of freedom of motion, which also limits the capacity of surgical technique, causes ergonomic inconvenience, often leads to an increase in the duration of the operation and maximizes the risk of intra- and postoperative complications. RSC eliminates the physiological tremor of the surgeon's hands, thus increasing the accuracy of his movements, and the three-dimensional image allows better coordination. On the other hand, despite the magnified high-definition image, the field of vision in the monitor might be narrower, which in some cases prevents the necessary visual control of the entire surgical field.

In a number of works, it is pointed out that the use of RSC allows to avoid the disadvantages of laparoscopy. At the same time, it enables to maintain the principle of low invasiveness of the intervention, thus decreasing the postoperative pain syndrome, as well as allowing to achieve early recovery of the patient and a quick return to the usual way of life, due to the high precision of work with tissues [25–28].

When evaluating the economic efficiency of the two surgical methods, laparoscopy turns out to be less expensive in terms of equipment depreciation and the cost of consumables [21, 22]. However, over time, the cost of RA operations is likely to decrease due to the constant process of training and accumulation of experience by surgeons, which will contribute to an increase of patients and a wide replication of the technique, which, in turn, will help level out the costs and solve the issue of economic efficiency.

The analysis of the literature we found did not give definite answers to the question of the advantage of laparoscopic or RA approaches in the treatment of patients with RE and HH. Despite the fact that RA operations continue to be a "piece goods" in a number of countries, robot-assisted surgery is actively developing and proving to be safe for patients.

The encouraging data on the learning curve of surgeons using RSC once again confirm that this is a very promising method. Due to the steadily growing number of RSC installed in hospitals, and, consequently, the increase in the number of robot-assisted operations, this method can become widespread in anti-reflux surgery.

Today, in Russia there are no clinical recommendations on the use of RSC in the treatment of patients with RE and HH, and the number of scientific papers on this topic is not numerous [29, 30]. Based on the experience of foreign surgeon colleagues, it is necessary to conduct our own research on this problem in order to work out indications for the choice of one or the other surgical approach, as well as to create a single transparent algorithm for the surgical treatment of RE patients, which could subsequently be included in domestic clinical guidelines.

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