

Current treatment of the inguinal hernia — the role of the totally extraperitoneal (TEP) hernia repair

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Abstract: Inguinal hernia repairs are one of the most common procedures performed in general surgical departments. Approximately 20 million hernia repairs are performed annually all over the world. According to the EHS guidelines, the recommended treatment methods of the inguinal hernia are tension-free techniques: the Lichtenstein open hernia repair and the laparoscopic transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) methods.

The TEP hernia repair, first performed by Duluq in 1992, is one of the three current leading techniques in the inguinal hernia repair. The most important advantage of this technique is minimal invasive access without the need to open the peritoneum, which carries a lower risk of abdominal organs injury. Additionally, the TEP method facilitates shorter recovery time, less postoperative pain and an earlier discharge from hospital. The aim of the article is to present the TEP method by comparing it with the other inguinal hernia repair techniques, on the basis of the available literature.

Key words: inguinal hernia, TEP, laparoscopy.

Inguinal hernia repairs are one of the most common procedures performed in general surgical departments. Approximately 20 million hernia repairs are performed annually all over the world [1]. The whole life risk of the occurrence of inguinal hernia is estimated at 27% in men and 3% in women [2]. Since the implementation of tension-free techniques, especially the Lichtenstein technique in 1984, the recurrence rate declined by 50–75% compared to tension techniques [3]. Another milestone in the development of inguinal hernia repair was the use of laparoscopic techniques.

The totally extraperitoneal (TEP inguinal hernia repair, first performed by Dulucq in 1992, together with the Lichtenstein technique and transabdominal (TAPP) technique, are among the current leading inguinal hernia repair methods. This method gained its importance over the last few years. According to the Swedish national register and German Herniamed register, TEP represents 25% of all hernia repairs in both countries respectively [4].

The most important advantage of this technique is the minimal invasive access without opening the peritoneum, which carries a lower risk of the abdominal organs injury [5]. Additionally, the TEP method facilitates shorter recovery time, less postoperative pain and earlier discharge from hospital [6]. According to the EHS guidelines, the recommended methods on the treatment of the inguinal hernia are tension-free techniques with synthetic mesh implantation: the Lichtenstein open hernia repair and the laparoscopic TAPP and TEP methods. Endoscopic procedures are preferred in cases of bilateral hernias and recurrent hernias after using the anterior hernia repair techniques [5, 7]. Choosing the best surgical procedure for a particular patient always requires consideration. No method is suitable for all kinds of hernias. An effective surgical technique should be characterized by a low complication rate, short learning curve, short recovery time, and cost effectiveness.

Surgical techniques

The TEP procedure can be performed under general or spinal anesthesia. The most popular technique is a multi-trocar procedure (as described below) but it is also possible to perform it as a single incision surgery (SILS-TEP) [8] or as a robotic surgery using Da Vinci platform [9]. It begins with a small incision (about 1 or 2 centimeter) below the umbilicus. The incision of the anterior sheath of the abdominal rectus muscle is then made. The next step after retracting the rectus muscles, is to create a space between the peritoneum, the abdominal rectus muscles and the gall bladder. The preperitoneal space is created with blunt dissection, using the Herloon balloon, the laparoscopic camera or a finger. A 10 millimeter port is placed through the previous incision below the umbilicus. Next a camera is inserted

(straight or oblique optic) through this port. Two additional ports are placed (depending on the medical center) in the midline between the umbilicus and pubis symphysis or one port halfway between the umbilicus and pubis symphysis and the second one near the anterior superior iliac spine, on the site of the operated hernia (Fig. 1).

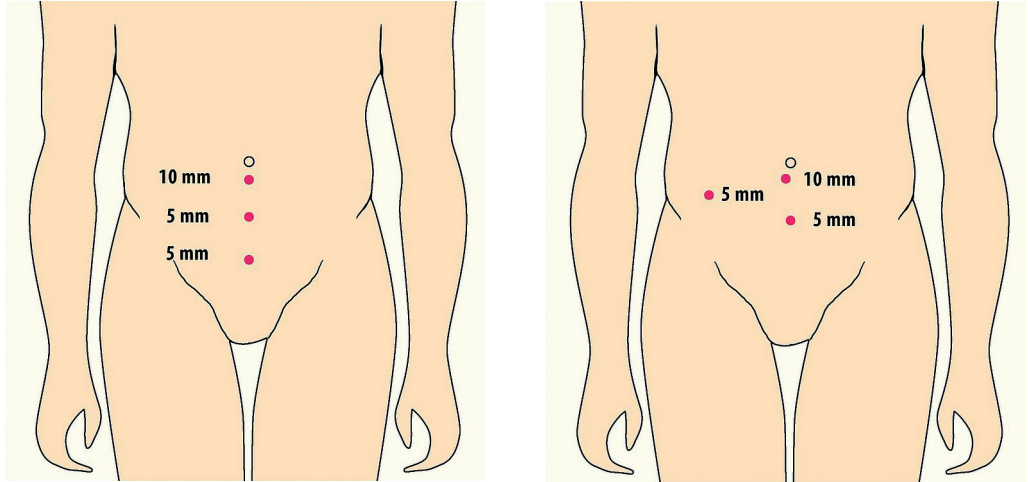


Fig. 1. Position of laparoscopic ports during TEP procedure.

The most important part of the operation includes the identification of typical topographic points such as: the hypogastric vessels, the pubic bone, the spermatic cord (Fig. 2). After the identification of the points, a space beyond the spermatic cord and above the iliopsoas muscles should be created. Then the hernia sac is carefully dissected and retracted in the cephalad direction. It is important to avoid the tearing of the hernia sac because it may lead the abdominal cavity to fill with gas and, as a consequence, to a significant reduction of the operating field. After separating the hernia sac a synthetic lightweight mesh is placed into the operating space. According to the guidelines, the size of the mesh should be at least $10 \times 15 \text{ cm}^2$. According to the IEHS recommendation a monofilament mesh with a pore size of at least 1.0–1.5 mm (usually meaning low-weight is thought to be most advantageous (Grade D) [10]. The mesh can be fixed by using glue or sutures to the Cooper's ligament, the pubic bone tubercle, the conjoint tendon and the abdominal rectus muscles. In many medical centers fixing of the mesh is not used. Correct positioning facilitates the removal of gas from the preperitoneal space. Returning the peritoneum to its primary position presses the mesh from the bottom, the rectus muscles from the top, contradicting the displacement of mesh and creating the so-called "sandwich effect" [11]. According to the EHS guidelines it is not recommended to fix the mesh by using non-resorbable

devices (strength of recommendation 1A). Mesh fixing can cause higher level of pain and increase the risk of perioperative complications [7].

Meta-analyses, conducted in 2010 by Tam *et al.*, didn't reveal any statistical difference between the mesh fixation and non-fixation according to the frequency of recurrences and acute or chronic postoperative pain [12]. In the publication of Buyikasik *et al.* a higher complication rate was found in the case of fixing mesh (pain, usage of narcotic drugs) without the benefit of reducing the recurrence rate at the same time [13]. Additionally, in the meta-analyses, Said *et al.* proved that non-fixation of mesh reduces the risk of nerve injury (genital branch of the genitor-femoral nerve, lateral cutaneous nerve of thigh) [14]. Taylor *et al.* in a randomized clinical trial, showed that mesh fixing is associated with greater risk of postoperative pain [15]. In the trial evaluating the displacement degree of the mesh with fixation and mesh without fixation on the basis of radiograms, there was no statistical difference between the position change of fixed mesh to the one without fixing. In both cases, mesh displacement was minimal and no more than 0.5 cm from its primary position [16].

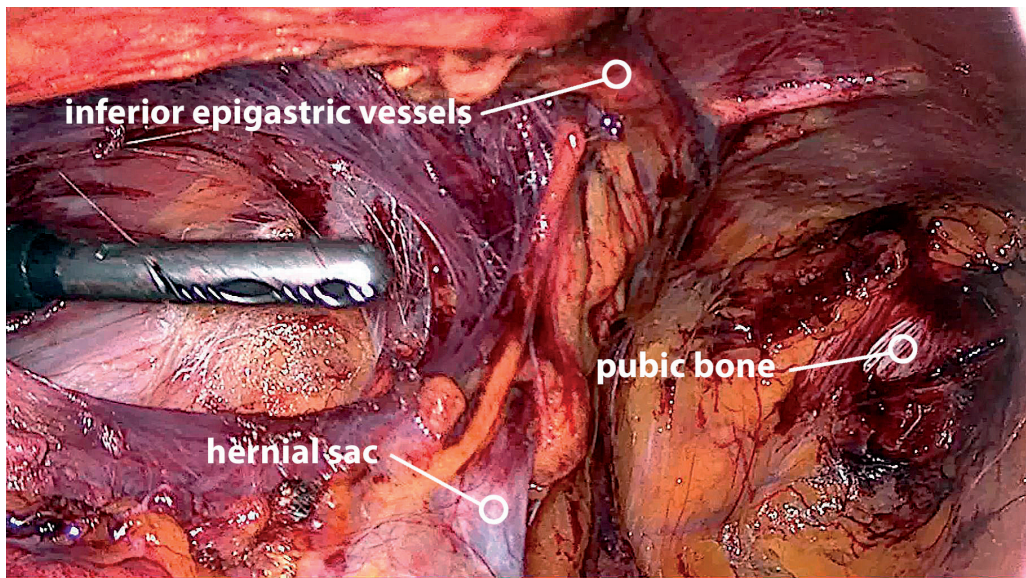


Fig. 2. The most important topographic points during TEP procedure.

In conclusion, the TEP hernia repair without mesh fixation is an effective and safe technique. It has been proven that mesh fixing doesn't reduce recurrence rate and can lead to an increase in pain, especially chronic [5, 13]. It seems that mesh fixation can play a role in preventing recurrences in case of type III hernia especially medial (according to EHS hernia classification) [17].

An important factor affecting the choice of the surgical technique is the time needed by a surgeon to gain proficiency — so-called “learning curve”. In the case of TEP, the curve is longer compared to the Lichtenstein method. It is believed that the reason for the elongation of the “learning curve” is the necessity to operate in the preperitoneal space — the space specifically created for the purpose of this procedure, which does not exist anatomically. Patients selection plays an important role in the first procedures. It was shown that the BMI value influences the operating time during “learning curve” [18]. Schouten *et al.* suggest that for the first treatment using the TEP method, slim patients with minor primary hernia without abdominal surgery are chosen [20]. Depending on the publication, the time needed to achieve full operating efficiency fluctuates from 20 to 400 repetitions [19–22]. In a prospective study of Suguita *et al.*, it was shown that the “learning curve” plateau is achieved after 65 repetitions. After this time, the percentage of complications decreased and the treatment time stabilized at around 28 min [1]. According to the EHS data, learning curve varies from 50 to 100 procedures and the first 50 procedures are the most crucial. Moreover, based on the available literature, there is no significant difference between the procedures performed by residents under appropriate supervision, compared to those performed by experienced surgeons [5].

Recovery

Inguinal hernia operations are common procedures among working people, that’s why the time needed to return to full activity depends on important socio-economic aspects. The above-mentioned advantages of endoscopic techniques imply short convalescence period, understood as the time needed to return to the daily pre-surgical activity and returning to work. Convalescence time differs, depending on the variety of recommendations in different medical centers and the level of activity of a particular patient. It was shown, that the time needed to return to full activity is influenced by the type of postoperative recommendations given to the patient⁶. Therefore, patients should be informed about the possibility of returning to full activity as soon as possible [5]. No relationship between the short convalescence time and recurrence rate was proven [5, 23].

The only factor limiting the return to activity is postoperative pain. After the TEP procedure, patients return to physical activity sooner than after the Lichtenstein method [5]. There are no significant differences compared to the TAPP method [23]. According to the available meta-analyzes, the recovery time in the case of endoscopic techniques was seven days shorter on average, compared to classical procedures [5, 24–28]. In a systematic review, conducted by Tovler *et al.*, the mean recovery time was 6 days [22].

Complications

The most important factors provided to estimate the effectiveness and safety of an operation, are perioperative and postoperative complication rates. There is a number of scientific reports, meta-analyses, prospective, and randomized trials evaluating the effectiveness and safety of the TEP procedure. It is particularly important to compare the incidence of complications after the TEP procedure compared to the other two leading techniques: Lichtenstein and the TAPP method.

The most common early complications after inguinal hernia repairs are: hematomas, seromas, urinary retention and surgical site infections. Total risk of complications after an inguinal hernia repair is estimated, depending on the source, from 15 to 28% [24–29]. Life-threatening complications are seldom. The risk of intestinal injury during a laparoscopic inguinal hernia repair is estimated from 0 to 0.21% [30–33] and postoperative bowel obstruction occurs in 0.07 to 0.4% of the cases [30, 32]. After the TEP procedure, compared to Lichtenstein method there were no significant differences in terms of testicular ischemia and spermatic cord injury between both techniques [30], hematomas, surgical site infections [5] and post-operative urinary retention are less frequent [34] but seromas are more common [5] (Table 1).

According to the several trials preperitoneal drainage for 24–48 h after TEP hernioplasty can effectively decrease seroma formation in the early postoperative period [34, 35]. However International Endohernia Society Guidelines (IEHS) doesn't recommend drainage after TEP as a routine procedure. According to the IEHS recommendations other techniques reducing the incidence of seroma are: complete reduction of hernia sac in case of indirect hernias and inversion of transversalis fascia in case of direct hernias [36].

In the majority of analyzes, there were no significant differences in the peri- and postoperative complications between the TEP and the TAPP method [20, 37]. In several reports, minor differences between the two methods can be found. In two multi-center studies conducted by Köckerling *et al.*, there were no differences in perioperative complications. However, a slightly higher percentage of postoperative complications (seromas) after TAPP was found in both primary and recurrent hernias. It was most likely associated with a greater proportion of scrotal hernias in patients operated by the TAPP method [37]. In a study by Gass *et al.* a significantly higher percentage of perioperative complications after TEP was discovered [38] (Table 2).

There are also several typical intraoperative complications associated with the TEP technique such as: tearing of the peritoneum, bladder injury and injury of the inferior epigastric vessels. The most common is tearing of the peritoneum, which occurs in 47% of cases [36]. In the case of large injury, conversion may be necessary. If the defect is small, it is possible to close it during the laparoscopic procedure (using stitches, staples or clips) [36]. Bladder injury, according to the IEHS guidelines, is

Table 1. Comparison of multicenter randomized trials TEP vs Lichtenstein.

Year	Author	n	TEP/Lichtenstein						
			n	Mean age (years)	Hematomas	Seromas	Urinary retention	Chronic pain	Recurrences
2004	Neumayer [43]	2164	1077/1087	59/58		16.4%/13.6%	2.8%/2.2%	9.0%/13.1%	8.1%/3.8%
2006–2010	Eklund [37, 44, 45]	1371	665/706	53/52	9.0%/11.2%	0.8%/0.8%	4.2%/7.5%	8.7%/17.6%	2.7%/0.7%
2010	Langeveld [45]	660	336/324	55/56	19.9%/20.1%	5.9%/7.4%	1.8%/0.3%	19.6%/20.1%	2.9%/2.2%

Table 2. Comparison of randomized and prospective trials TEP vs TAPP.

Year	Author	n	TEP/TAPP					
			n	Mean age (years)	Surgical site infection	Seromas	Chronic pain	Recurrences
randomized								
2012	Krishna [46]	100	53/47	48/51	1.9%/6.4%	37.8%/18.3%		0/0
2013	Bansal [50]	314	160/154	50.5/43	1.8%/3.2%	32.5%/16.2 %	1.25%/1.3%	0/0.006%
prospective								
2015	Köckerling [32]	17587	10887/6700	55/55	0.04%/0.04%	0.5%/3.2%		0.82%/0.90%
2017	Köckerling [33]	2246	782/1464	58/59	0.00%/0.07%	0.5%/3.2%	4.5%/3.4%	0.90%/1.43%

estimated from 0.006 to 0.3% and if it is diagnosed intraoperatively, it can be repair endoscopically. It is said to be the most common major complication of TEP. Injury of the inferior epigastric vessels is usually managed laparoscopically and occurs depending of the different publications varies from 0.005 to 0.03% [39, 40].

Recurrences

Depending on the source recurrence rate after the TEP inguinal hernia repair varies from 0.94% to 5.3% [2, 5, 34]. In the first studies, comparing the TEP method with the Lichtenstein method, the recurrence rate was significantly higher for laparoscopic operation [5]. An inexperienced surgeon [5], insufficient dissection of the preperitoneal space [37] or inadequate mesh size implantation [5] were supposed to be the causes of the higher recurrence rate after TEP. There was no difference in the recurrence rate between the laparoscopic surgery and the Lichtenstein method in subsequent systematic reviews, meta-analyzes and other studies [5, 34, 41].

An analysis of older studies, with higher recurrence rate after the TEP method, was conducted. In a study performed by Eklund *et al.* in 2009, one surgeon was responsible for nearly one third of recurrences after TEP. After excluding data from the surgeon's work, there was no statistically-significant difference in the recurrence rate between these two techniques [38]. Similarly, in the systematic review of Kuhry *et al.*, the higher percentage of recurrences was significantly affected by the results from one of the centers, where 7.6×15 cm meshes were placed [25]. After excluding this center from the analysis, no differences were found in the frequency of recurrences between the analyzed groups [5]. Based on the available literature, no significant differences were found in the recurrence rates after the TEP and the TAPP procedures [23].

Chronic pain

Chronic pain is usually defined as pain lasting over 3 months and affecting daily activity. There are many hypotheses explaining chronic pain development. Intraoperative nerve injury (neuropathic pain) and prolonged inflammatory reaction (nociceptive pain) are most commonly considered as its cause. In the case of TEP, it is considered that chronic pain is more often associated with an inflammatory reaction, caused by the formation of a scar. However, no correlation was found between the severity of the inflammatory reaction and the occurrence of chronic pain after the TEP procedure [41].

The incidence of chronic pain after inguinal hernia repairs varies from 2 to 35% depending on the surgical technique, type of pain definition applied, methods used for assessing pain level, and the time from surgery [43]. In the case of endoscopic techniques, it affects 1 to 16% of patients [44]. It has been unequivocally demonstrated

that the occurrence of postoperative chronic pain is affected by the severity of the preoperative pain [45]. In addition, older people are less likely exposed to chronic pain development [5, 45]. What is important, the pain after the TEP procedure tends to decrease gradually in time. In a study conducted by Burgmans *et al.*, pain symptoms occurred in about 10% of patients one year after surgery, with medium and severe pain occurring in 1% of patients [44]. It was demonstrated in great amount of trials that chronic pain after a TEP surgery occurs less often than after using the Lichtenstein method [5, 30, 43, 45].

There are contradictory reports about the incidence of chronic pain after TEP compared to the TAPP method. Some studies have shown that chronic pain occurs less frequently after TEP [44], whereas in others, no significant differences were found between both methods [46, 47]. In the remaining studies, the chronic pain after the TEP procedure was more frequent [48].

Quality of life

The most common parameters used to evaluate the effectiveness of a surgical procedure are the frequency of complications and the recurrence rate. However, subjective patient satisfaction after surgical treatment, resulting in improvement of life functioning and the quality of life level, is of equal importance. Currently, the quality of life (QOL) remains one of the most important parameters for evaluation of the effectiveness of surgical procedures. There is number of tools developed to assess patient satisfaction after a surgical treatment (eg. SF-36, CCS). The laparoscopic procedure, whether using the TAPP or the TEP method, provides a better QOL rate, compared to open techniques. In the studies conducted by Bansal *et al.* and Meyers *et al.*, a statistically-significant improvement in the quality of life after a laparoscopic inguinal hernia repair was demonstrated [49].

Conclusions

The TEP hernia repair in the hands of an experienced surgeon, is a great tool. It is a safe and an effective procedure allowing the patients a quick return to full activity and providing high quality of life. Although it does not differ in terms of the frequency of recurrences, compared to the Lichtenstein method, it has an advantage over it in terms of faster convalescence time and the possibility of simultaneous supply of bilateral inguinal hernia.

Based on the available literature, the TEP method seems to be an equivalent technique compared to the TAPP procedure. The benefits that may plead in favor of the procedure conducted from preperitoneal approach are: a reduced risk of abdominal organs injury and a reduced risk of post-trocar hernias. Lichtenstein's

procedure has its advantage in a statistically shorter “learning curve”, shorter operation time and lower costs of the surgery. However, taking into account the total socio-economic society costs related to the extended convalescence time after an open surgery, the laparoscopic surgery does not seem to be so expensive.

In conclusion, the TEP method remains one of the leading inguinal hernia repair procedures. The choice of a specific surgical technique depends on the preferences of the surgeon and on the unique characteristics of a particular patient. Undoubtedly, the TEP method has its priority and is recommended by EHS guidelines [5, 7] in the bilateral hernias and recurrent hernias after open hernia repair techniques.

Conflict of interest

None declared.

References

1. Suguita F.Y., Futema E., et al.: Learning curve takes 65 repetition of totally extraperitoneal laparoscopy on inguinal hernias for reduction of operating time and complications. *Surg Endosc.* 2017; 31: 3939–3945.
2. Rutkow I.M., Robbins A.W.: Demographic, classificatory and socioeconomic aspects of hernia repair in the United States. *Surg Clin North Am.* 1993; 73: 413–426.
3. Schjøth-Iversen L., Refsum A., Brudvik K.W.: Factors associated with hernia recurrence after laparoscopic total extraperitoneal repair for inguinal hernia: a 2 year prospective cohort study. *Hernia.* 2017; 21: 729–735.
4. Sharma A., Chelewat P.: Endo-laparoscopic inguinal hernia repair: What is the role? *Asian J Endosc Surg.* 2017; 10: 111–118.
5. Simons M.P., Aufenacker T., et al.: European Hernia Society guidelines on the treatment of inguinal hernia in adult patients. *Hernia.* 2009; 13: 343–403.
6. Garofalo F., Mota-Moya P., et al.: Total extraperitoneal hernia repair: residency teaching program and outcome evaluation. *World J Surg.* 2017; 41: 100–105.
7. Miserez M., Peeters E., et al.: Update with level 1 studies of the European Hernia Society guidelines on the treatment of inguinal hernia in adult patients. *Hernia.* 2014; 18: 151–163.
8. Dapri G., Gerard L., Paesmans M.: First 200 consecutive transumbilical single-incision laparoscopic TEPs. *Hernia.* 2017; 21 (1): 29–35.
9. Cestari A., Galli A.C., Sangalli M.N.: Totally extraperitoneal (TEP) bilateral hernioplasty using the Single Site® robotic da Vinci platform (DV-SS TEP): description of the technique and preliminary results. *Hernia.* 2017; 21 (3): 383–389.
10. Bittner R., Arregui M.E., Bisgaard T.: Guidelines for laparoscopic (TAPP) and endoscopic (TEP) treatment of inguinal Hernia. International Endohernia Society (IEHS). *Surg Endosc.* 2011; 25 (9): 2773–2843.
11. Garg P., Nair S., Shereef M., et al.: Mesh fixation comparing to non-fixation in total extraperitoneal inguinal hernia repair: a randomized controlled trial in a rural center in India. *Surg Endosc.* 2011; 25: 3300–3306.
12. Tam K.W., Liang H.H., Chai C.Y.: Outcomes of staple fixation of mesh vs. non fixation in laparoscopic total extraperitoneal inguinal repair: a meta-analysis of randomized controlled trails. *World J Surg.* 2010; 34: 3065–3074.

13. Buyukasik K., Ari A., Akce B., et al.: Comparison of mesh fixation and non-fixation in laparoscopic totally extraperitoneal inguinal hernia repair. *Hernia*. 2017; 21: 543–548.
14. Sajid M.S., Ladwa N., Kalra L., et al.: A meta-analysis examining the use of tackler fixation versus non fixation of mesh in laparoscopic inguinal hernia repair. *Int J Surg*. 2010; 10: 224–231.
15. Taylor C., Layani L., Liew V., et al.: Laparoscopic inguinal hernia repair without mesh fixation, early results of large randomized clinical trial. *Surg Endosc*. 2008; 22: 757–762.
16. Paggi Claus C.M., Moreira Rocha G., Ligoeki Campos A.C., et al.: Mesh displacement after bilateral inguinal hernia repair with no fixation. *JSLs*. 2017; 21: e2017.00033.
17. Miserez M., Alexandre J.H., Campanelli G., et al.: The European hernia society groin hernia classification: simple and easy to remember. *Hernia*. 2017; 11: 113–116.
18. Schouten N., Simmermacher R.K., van Dalen T., et al.: Is there an end of the “learning curve” of endoscopic totally extra-peritoneal (TEP) hernia repair? *Surg Endosc*. 2013; 27: 789–794.
19. Wake B.L., McCormack K., Fraser C., et al.: Trans abdominal pre-peritoneal (TAPP) vs totally extraperitoneal (TEP) laparoscopic techniques for inguinal hernia repair. *Cochrane Database Syst Rev*. 2005; 25: CD004703.
20. Choi Y.Y., Kim Z., Hur K.Y.: Learning curve for laparoscopic totally extraperitoneal repair of inguinal hernia. *Can J Surg*. 2012; 55: 33–36.
21. Heidenberg J., Kendrick M.L., Miele T., Farley D.R.: Totally extraperitoneal (TEP) approach for inguinal hernia: the favorable learning curve for trainees. *Curr Surg*. 2003; 60: 65–68.
22. Hasbahceci M., Basak F., Acar A., Alimoglu O.: A new proposal for learning curve of TEP inguinal hernia repair. Ability to complete operation endoscopically as a first phase of learning curve. *Minim Invasive Surg* 2014; 2014: 528517.
23. Bittner R., Sauerland S., Schmedt C.G.: Comparison of endoscopic techniques vs Shouldice and other open non-mesh techniques for inguinal hernia repair: a meta-analysis of randomized controlled trials. *Surg Endosc*. 2005; 19: 605–615.
24. Bringman S., Ramel S., Heikkinen T.J., et al.: Tension-free inguinal hernia repair: TEP versus mesh-plug versus Lichtenstein: a prospective, randomized and controlled trial. *Ann Surg*. 2003; 237: 142–147.
25. Kuhry E., van Veen R.N., Langeveld H.R., et al.: Open or endoscopic total extraperitoneal inguinal hernia repair? A systematic review. *Surg Endosc*. 2007; 21: 161–166.
26. Lau H., Patil N.G., Yuen W.K.: Day-case endoscopic totally extraperitoneal inguinal hernioplasty versus open Lichtenstein hernioplasty for unilateral primary inguinal hernia in males: a randomized controlled trial. *Surg Endosc*. 2006; 20: 76–81.
27. McCormack K., Scott N.W., Go P.M.: Laparoscopic techniques versus open techniques for inguinal hernia repair. *EU Hernia Trialist Collaboration*. *Cochrane Database Syst Rev*. 2003; CD001785.
28. McCormack K., Wake B., Perez J.: Laparoscopic surgery for inguinal hernia repair: systematic review of effectiveness and economic evaluation. *Health Technol Assess*. 2005; 9: 1–203.
29. Fitzgibbons R.J. Jr, Camps J., Cornet D.A., et al.: Laparoscopic inguinal hernia. Results of multicenter trial. *Ann Surg*. 1995; 221: 3–13.
30. Tamme C., Scheidbach H., Hampe C., et al.: Totally extraperitoneal endoscopic inguinal hernia repair (TEP). *Surg Endosc* 2003; 17: 190–195.
31. Tucker J.G., Wilson R.A., Ramshaw B.J., et al.: Laparoscopic herniorrhaphy: technical concerns in prevention of complications and early recurrence. *Ann Surg*. 1995; 61: 36–39.
32. Phillips E.H., Arregui M., Carroll B.J., et al.: Incidence of complications following laparoscopic hernioplasty. *Surg Endosc*. 1995; 9: 16–21.
33. Fan J.K., Liu J., Chen K.: Preperitoneal closed-system suction drainage after totally extraperitoneal hernioplasty in the prevention of early seroma formation: a prospective double-blind randomized controlled trial. *Hernia*. 2018; 22 (3): 455–465. doi: 10.1007/s10029-018-1731-2.
34. Mihaleanu F., Chiorescu S., Grad O., et al.: The Surgical Treatment of Inguinal Hernia Using the Laparoscopic Totally Extra-Peritoneal (TEP) Technique. *Clujul Med*. 2015; 88 (1): 58–64.

35. Bittner R., Arregui M.E., Bisgaard T., et al.: Guidelines for laparoscopic (TAPP) and endoscopic (TEP) treatment of inguinal Hernia [International Endohernia Society (IEHS). Surg Endosc. 2011 Sep; 25 (9): 2773–2843.
36. Köckerling F., Bittner R., Jacob D.A., et al.: TEP versus TAPP: comparison of the perioperative outcome in 17,587 patients with primary unilateral inguinal hernia. Surg Endosc. 2015; 29: 3750–3760.
37. Gass M., Scheiwiller A., Sykora M., Metzger J.: TAPP or TEP for recurrent inguinal hernia? Population-based analysis of prospective data on 1309 patients undergoing endoscopic repair for recurrent inguinal hernia. World J Surg. 2016; 40: 2348–2352.
38. Tamma C., Scheidbach H., Hampe C., et al.: Totally extraperitoneal endoscopic inguinal hernia repair (TEP). Surg Endosc. 2003; 17: 190–195.
39. Eklund A.S., Montgomery A.K., Rasmussen I.C., et al.: Low recurrence rate after laparoscopic (TEP) and open (Lichtenstein) inguinal hernia repair: a randomized controlled, multi-center trial with 5-year follow-up. Ann Surg. 2009; 249: 33–38.
40. Koning G.G., Wetterslev J., van Laarhoven C.J.H.M.: The totally extraperitoneal method versus Lichtenstein's technique for inguinal hernia repair: a systematic review with meta-analyses and trial sequential analyses of randomized clinical trials. PloS One 2013; 8 (1): e52599. doi: 10.1371/journal.pone.0052599.
41. Burgmans J.P., Voorbrood C.E., van Dalen T., et al.: Chronic pain after TEP inguinal hernia repair, does MRI reveal a cause? Hernia. 2016; 20: 55–62.
42. Lundström K.J., Holmberg H., Montgomery A., Nordin P.: Patient-reported rates of chronic pain and recurrence after groin hernia repair. Br J Surg. 2018; 105: 106–112.
43. Burgmans J.P., Schouten N., Clevers G.J., et al.: Pain after totally extraperitoneal (TEP) hernia repair might fade out within a year. Hernia. 2015; 19: 579–585.
44. Eklund A., Montgomery A., Bergkvist L., Rudberg C.: Swedish multicenter trial of inguinal hernia repair by laparoscopy (SMIL) study group. Chronic pain 5 years after randomized comparison of laparoscopic and Lichtenstein inguinal hernia repair. Br J Surg. 2010; 97: 600–608.
45. Langeveld H.R., van't Riet M., Weidema W.F.: Total extraperitoneal inguinal hernia repair compared with Lichtenstein (the LEVEL-Trial): a randomized controlled trial. Ann Surg. 2010 May; 251 (5): 819–824.
46. Krishna A., Misra M.C., Bansal V.K., et al.: Laparoscopic inguinal hernia repair: transabdominal pre-peritoneal (TAPP) versus totally extraperitoneal (TEP) approach: A prospective randomized controlled trial. Surg Endosc. 2012; 26: 639–649.
47. Bansal V.K., Krishna A., Manek P., et al.: A prospective randomized comparison of testicular functions, sexual functions and quality of life following laparoscopic totally extra-peritoneal (TEP) and transabdominal pre-peritoneal (TAPP) inguinal hernia repairs. Surg Endosc. 2016; 31: 1478–1486.
48. McCormack K., Wake B.L., et al.: Transabdominal pre-peritoneal (TAPP) versus totally extraperitoneal (TEP) laparoscopic techniques for inguinal hernia repair: a systematic review. Hernia. 2005; 9: 109–114.
49. Meyers E., Bowne K.M., Kavanagh D.O., Hurley M.: Laparoscopic (TEP) versus Lichtenstein inguinal hernia repair: a comparison of quality of life outcomes. World J Surg. 2010; 34: 3059–3064.
50. Bansal V., Misra M., Babu D.: A prospective, randomized comparison of long-term outcomes: chronic groin pain and quality of life following totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP) laparoscopic inguinal hernia repair. Surg Endosc. 2013; 27: 2373–2382.