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ORIGINAL ARTICLE

First 200 consecutive transumbilical single-incision laparoscopic TEPs

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Abstract
Background Endoscopic pre-peritoneal mesh repair (TEP) through single-incision laparoscopy (SIL) permits placement of a large mesh through a final millimetric umbilical scar. This prospective study evaluates the first 200 consecutive SILTEPs performed by a single surgeon.
Patients and methods Between November 2011 and September 2015, 200 consecutive SILTEPs were performed in 161 patients. The mean age was 49.8 ± 16.3 years and the mean BMI was 24.5 ± 3.4 kg/m^2. The technique involved one 11-mm trocar, one 10-mm 0° scope and curved reusable instruments. A supplementary 1.8-mm straight trocarless grasping forceps was percutaneously inserted for perioperative complications or difficulties.
Results A unilateral hernia repair was performed in 122 patients, and a bilateral repair in 39 patients. The total operative time was 57.4 ± 22.3 min, and pure laparoscopic time was 46.6 ± 21.6 min. There was no need for insertion of a supplementary 5-mm trocar, and the need for insertion of 1.8-mm trocarless grasper was 32.9%. Perioperative complications occurred in 73 patients. The mean final scar length was 15.3 ± 2.6 mm. The mean hospital stay was 1.0 ± 0.3 days. Postoperative complications at the access site affected 15 patients and at the hernia site 31 patients. After a mean follow-up of 25.4 ± 12.3 months, there was one asymptomatic, small incisional hernia at the access site as well as one reoperation for recurrent inguinal hernia at 16 months. No other late complications were registered.
Conclusion Transumbilical SILTEP permits placement of a large mesh through a final millimetric scar. Getting over the learning curve in conventional multitrocar TEP is mandatory. As per our institute's algorithm, the contraindications continue to be giant inguino-scrotal, incarcerated and recurrent inguinal hernias.

Keywords Inguinal hernia · TEP · Single incision · Single port · Laparoscopy

Introduction

Inguinal hernia repair by minimally invasive surgery (MIS) offers advantages over open repair such as reduced surgical scars, a quick return to normal activities and a lower incidence of total postoperative complications [1]. MIS hernia repair can be performed through transabdominal pre-peritoneal mesh repair (TAPP) or by total endoscopic pre-peritoneal mesh repair (TEP). The learning curve to correctly perform a TEP procedure remains high [2].

Single-incision laparoscopy (SIL) has attracted interest in the past decade, mainly because it improves cosmetic outcomes [3]. The first TEP by SIL was reported by Cugura [4], and the first TAPP was reported by Kroh [5].

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In our institute, both conventional laparoscopic TAPP and TEP are routinely performed, but TEP remains the first choice of treatment, except when there are direct indications for TAPP; this occurs when patients present with giant inguino-scrotal, incarcerated or recurrent inguinal hernias.

In the philosophy of SIL, the TEP procedure makes sense because it permits the placement of a large mesh into the retroperitoneal space through a final millimetric umbilical scar without additional trocars. Aside from the advantage of remaining in the pre-peritoneal space and out of the peritoneal cavity, SILTEP contributes to the improved final cosmetic result.

Patients and methods

From November 2011 to September 2015, 200 consecutive SILTEPs were performed by the same surgeon (first author) in 161 patients. The surgeon had already performed 500 conventional TEPs. The patients included 147 males and 14 females. The mean age was 49.8 ± 6.3 years (17–89) and the mean BMI was 24.5 ± 3.4 kg/m^2 (17.3–36.3).

Patients presenting with giant inguino-scrotal, incarcerated and recurrent inguinal hernias were directly referred to TAPP repair after the first consultation, as per our institute's algorithm. If the patient presented a contraindication to general anesthesia and laparoscopy, the anterior open approach was proposed. If the patient presented with a BMI >40 kg/m^2 or a surgery had already been performed in the lower abdominal quadrants, a conventional multitrocar TEP (CMTEP) was proposed.

Unilateral as well as bilateral hernias were repaired. If the patient presented with a concomitant small umbilical hernia, the repair was performed by open raphy through the same incision at the end of the SILTEP.

The total operative time was calculated from the skin incision until fascia closure, and pure laparoscopic time included the beginning of CO_2 insufflation until the desufflation of the pre-peritoneal space. In case of umbilical hernia raphy, the added operative time was included in the total value.

Insertion of a supplementary 5-mm trocar and instrument out of the umbilical scar was considered for perioperative complications or difficulties, as was a supplementary 1.8-mm straight trocarless grasping forceps. Non-absorbable tacks for mesh fixation were used only if necessary, e.g., when faced with a risk of mesh slippage or direct hernia. Perioperative as well as postoperative complications were recorded.

Postoperative pain was measured using the VAS score every 6 h until the patient was discharged; after the discharge, it was measured by the prescription of 1–3 g of paracetamol/day.

The patients were followed up through office consultations at 10 days and then at 1, 3, 6, 12 and 24 months after the procedure. After 24 months, a telephone call was made.

Statistical analysis

The purpose of this manuscript is to report our experience with the procedure in a single series of patients who were all operated on with the same surgical intervention. We therefore carried out a descriptive analysis only on a prospective database. We estimated the distributions of categorical variables using contingency tables and calculated the observed proportions. For continuous variables, we chose to summarize their distributions using the mean as the location parameter and the standard deviation as the dispersion parameter, together with the observed range.

Surgical technique

The patient was placed in a supine position with the arms alongside the body and the legs straight. Both the position of the team and the choice of umbilical incision side were dependent on the localization of the hernia defect, adhering to the laparoscopic principle of alignment between the surgeon's head, the operative field and the video monitor [6]. If the hernia defect was located on the right inguinal region, the surgeon stood to the patient's left, the camera assistant to the patient's right and the scrub nurse to the patient's left and surgeon's left. If the hernia defect was located on the left inguinal region, the surgeon stood to the patient's right, the camera assistant to the patient's left and the scrub nurse to the patient's right and the surgeon's right. If the patient presented with a bilateral hernia, the right side was approached first. The central umbilical scar was grasped and taken laterally on the right side. The cutaneous scar inside the umbilicus was incised more on the left side, and the subcutaneous tissue was dissected until reaching the fascia of the left anterior rectus muscle. The anterior fascia was exposed and opened vertically. A purse-string suture using Vicryl 1 was placed at the 9, 10, 12, 2, 4, 6, 8 and 9 o'clock positions. This suture was maintained externally under tension. The left rectus muscle fibers were laterally retracted and an 11-mm rigid trocar (Fig. 1a) was introduced behind the rectus muscle fibers and above the posterior fascia into the pre-peritoneal space. A 10-mm, straight, 0°, and regular-length scope (Fig. 1b) was advanced through the 11-mm trocar, and the pre-peritoneal space was insufflated. The operative room table was placed in a moderate Trendelenburg position with a more left-sided tilt. The scope was used to dissect the pre-peritoneal space. It was first pushed against the

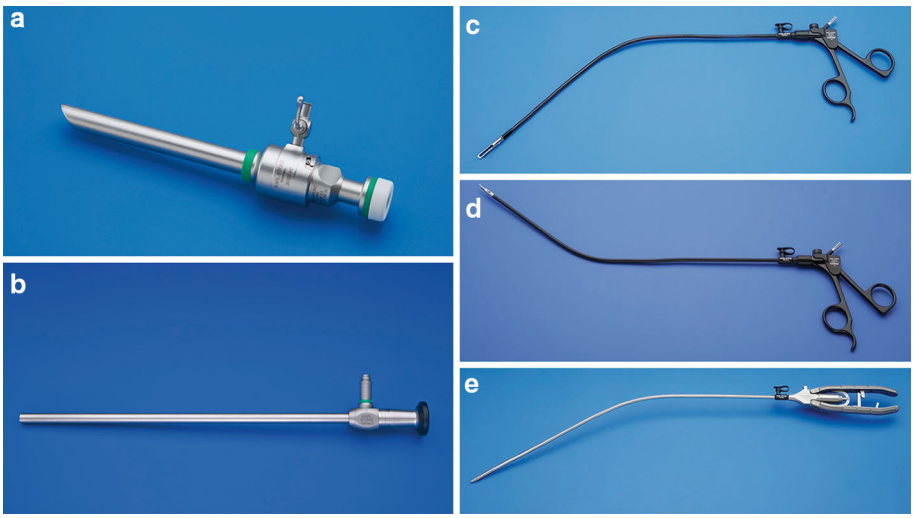

Fig. 1 11-mm rigid reusable trocar (**a**), 10-mm straight 0° regular length scope (**b**), DAPRI monocurved grasping forceps (**c**), DAPRI monocurved scissors (**d**), DAPRI monocurved needle holder (**e**) (Karl Storz—Endoskope, Tuttlingen, Germany)

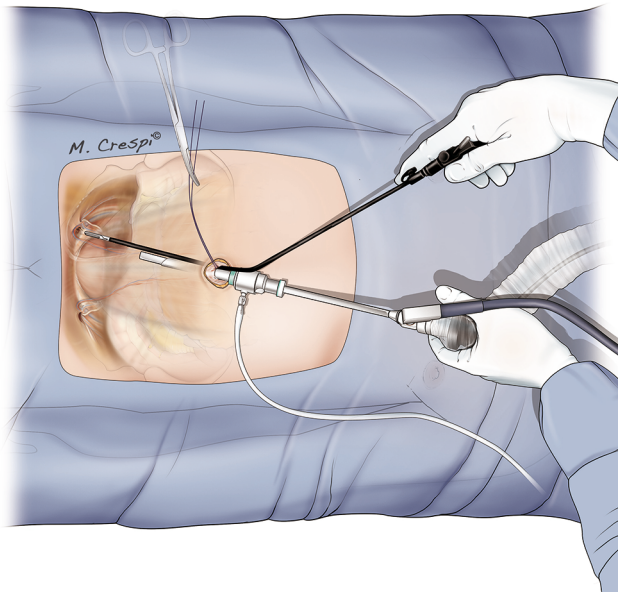

Fig. 2 Optical system and grasping forceps at the umbilical access

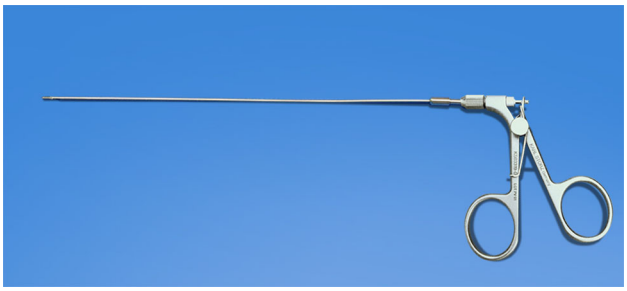

Fig. 3 DAPRI 1.8-mm trocarless grasping forceps (Karl Storz—Endoskope)

pubic bone and then laterally to create a medial-to-lateral dissection; this movement is called "rowing the boat". The scope must move laterally, staying behind the epigastric vessels first and then moving posteriorly to the trasversalis fascia. The curved instruments according to DAPRI (Karl Storz—Endoskope, Tuttlingen, Germany), such as the monocurved grasping forceps (Fig. 1c), the monocurved scissors (Fig. 1d), the monocurved needle holder (Fig. 1e) and the straight 5-mm tack device (Protack, Covidien, New Haven, CT, US), were inserted parallel to the 11-mm trocar and inside the purse-string suture at the 9 o'clock position (Fig. 2). The suture was adjusted to maintain a tight seal around the 5-mm instrument and the 11-mm trocar and was opened only to change instruments. The insertion of the monocurved grasping forceps was performed when the hernia sac needed to be retracted and the pre-peritoneal space was well dissected. The grasper helped with completing the retraction of the posterior peritoneal sheet in the direction of the patient's head. The deferent duct (male) or the round ligament (female) as well as the spermatic vessels (male) were freed from the peritoneal sheet. Because of the curve of the grasping forceps, there was no conflict between the hands of the surgeon and camera assistant extracorporeally (Fig. 2). If the inguinal hernia was direct, the monocurved grasping forceps alone was sufficient to retract the hernia sac. In case of perioperative complications or sometimes indirect inguinal hernia, a 1.8-mm trocarless grasping forceps according to DAPRI (Karl Storz—Endoskope) (Fig. 3) was inserted on the linea alba between the umbilicus and the pubic bone, helping with traction and countertraction. This millimetric grasper was inserted through a skin puncture made by a classic Veress needle (same diameter). If the patient presented with a bilateral hernia, the left pre-peritoneal space was prepared after the right side and before the insertion of the mesh into the right space. The scope was used to dissect the left pre-peritoneal space; if necessary, the monocurved grasping forceps was inserted to retract the hernia sac. The operative room table was placed at a more right-sided tilt,

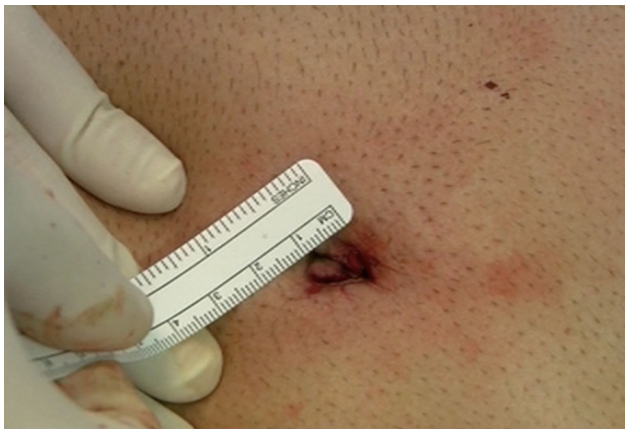

Fig. 4 Final scar length

maintaining the Trendelenburg positioning. A 15 cm (width) × 10 cm (medial height) × 8 cm (lateral height) polypropylene mesh (Bard Davol Inc., Warwick, RI, US) was chosen and prepared. Two sutures using Vicyrl 2/0 were placed at the inferior corners of the mesh before its insertion: one at the medial corner (long suture) and another at the lateral corner (short). These sutures helped with the orientation of the mesh once it was introduced into the pre-peritoneal space. The mesh was rolled tightly to be inserted through the 11-mm trocar into the pre-peritoneal space using a straight 5-mm grasping forceps. Then, it was opened by the monocurved grasper and placed into the pre-peritoneal space, positioning the two inferior corners (sutures) in the correct location. If necessary, the mesh was fixed by 2/3 tacks on the pubic bone using a straight 5-mm tack device inserted parallel to the 11-mm trocar and inside the purse-string suture at the 9 o'clock position. In the case of a bilateral hernia, a second mesh was placed into the left space (as described above for the right side) after having placed the right mesh. Finally, no drain was left in the inguinal region, and the operative room table was repositioned without any tilt or use of the Trendelenburg position, as in the beginning of the procedure. The pre-peritoneal space was deflated under mesh vision. The purse-string suture, placed at the beginning on the fascia of the rectus muscle, was tightened. Intradermic sutures were used for the cutaneous scar (Fig. 4).

Results

A unilateral hernia repair was performed in 122 patients (75.7%) and a bilateral hernia repair in 39 patients (24.2%). Considering the hernia repair singularly, indirect hernia was found in 96 cases, direct hernia in 54 cases, small inguino-scrotal hernia in 21 cases, direct plus indirect hernias in 22 cases, indirect plus femoral hernias in 4 cases, direct plus femoral hernias in 2 cases and small inguino-scrotal plus femoral hernias in 1 case. An umbilical hernia raphy was repaired at the end of the SILTEP procedure in 19 patients (11.8%).

Table 1 Perioperative complications

Peritoneal hernia sheet tear	69
Peritoneal access-site sheet tear	2
Epigastric vessel bleeding	2
Spermatic vessel bleeding	1
Corona mortis bleeding	1

Table 2 Postoperative VAS score values

	Mean ± SD (range)
VAS 6 h	5.5 ± 2.3 (2–9)
VAS 12 h	3.8 ± 2.2 (0–9)
VAS 18 h	3.2 ± 2.3 (0–9)
VAS 24 h	2.7 ± 2.2 (0–9)
VAS 30 h	2.5 ± 1.5 (0–6)
VAS 36 h	3.5 ± 2.1 (0–6)
VAS 42 h	3.0 ± 2.2 (0–6)
VAS 48 h	4.0 ± 2.1 (0–6)

The total operative time was 57.4 ± 22.3 min (23–122), and pure laparoscopic time was 46.6 ± 21.6 min (16–107). The total time for the unilateral hernia was 51.3 ± 17.3 min (23–111), while for the bilateral hernia 76.5 ± 25.4 min (30–122). The mean partial time needed to repair the umbilical hernia in 19 patients was 9.8 min (3–23). There was no insertion of a supplementary 5-mm trocar, and the insertion of 1.8-mm straight trocarless grasping forceps was adopted in 53 patients (32.9%). The mesh was fixed by tacks in 62 patients (38.5%). Perioperative complications occurred in 73 patients (45.3%; Table 1).

The mean final scar length was 15.3 ± 2.6 mm (10–28), and the mean blood loss was 4.4 ± 12.5 cc (0–150). The mean hospital stay was 1.0 ± 0.3 days (0.5–2). The mean VAS pain score was recorded (Table 2); these values were clearly dependent on the patients' discharge times (after 30 h, the number of patients still hospitalized was reduced). After discharge, 38 patients (23.6%) required the use of 1–3 g of paracetamol/day for more than 5 days, and 9 of them (5.5%) between 10 and 14 days.

Postoperative early complications (<30 days) (Table 3) related to the access site were registered in 15 patients (9.3%) and those related to the hernia site were observed in 31 patients (19.2%). One patient (under anticoagulant therapy) was reoperated on the 3rd postoperative day for bleeding in the pre-peritoneal space.

Table 3 Early postoperative complications

	Access site	Hernia site
Abscess	1	0
Seroma	1	9
Hematoma	13	21
Hemo-pre-peritoneum	0	1
Total	15	31

After a mean follow-up of 25.4 ± 12.3 months (6–51), there was one asymptomatic, small (5 mm) incisional hernia at the access site after 6 months (0.6%) as well as one reoperation for recurrent inguinal hernia after 16 months (0.6%). No other late complications (>30 days) were registered.

Discussion

Selection of patients in this preliminary SILTEP series was not based on BMI because no super-obese ($50 < BMI < 60$ kg/m^2) or super super-obese patients ($BMI > 60$ kg/m^2) were consulted. It is likely that the feasibility of this technique will need to be re-evaluated given the various classes of obesity.

Unilateral and bilateral hernias were treated by SIL without distinction, and the presence of a small umbilical hernia was considered a repair at the end of the SILTEP by open raphy. During follow-up, these patients did not show any recurrence of the repaired umbilical hernia.

Our mean operative time remains lower than the time to perform a CMTEP in a less experienced surgeon's hands [7], because this procedure is relatively easy after moving past the steep learning curve in CMTEP. However, a difference between the total operative time and the pure laparoscopic time is evident in the technique reported here and reflects various factors. The step of the fascia opening and purse-string suture placement is time-consuming and must be performed with care, similar to the step of the fascia closure at the end of each SIL procedure. If the purse-string suture is not executed well, a leakage of pneumo-pre-peritoneum appears and the procedure becomes impossible to continue. Obviously, a longer operative time is required if the procedure is bilateral, as it was for 39 patients in our series. Finally, in patients undergoing an umbilical hernia raphy repair, extra time was added to the total operative time value; this resulted in a non-equal result between total time and laparoscopic times.

On the other hand, the repair of a non-complicated hernia enabled a shorter mean total operative time. Moreover, because the dissection of the pre-peritoneal space was entirely achieved by the scope, the laparoscopic time enhanced this aspect, keeping the value inferior to the data reported in the literature [8–11].

There was no need to insert a supplementary 5-mm trocar due to the occurrence of perioperative complications or difficulties, although the two-trocar TEP remains a bridge between the SILTEP and the CMTEP [12]. In case of a peritoneal sheet tear or small inguino-scrotal sac sectioning, a millimetric trocarless grasping forceps was inserted, helping with the peritoneal closure together with the monocurved needle holder. This strategy prevented an increase in the operative time and enabled the achievement of satisfactory cosmetic results, because the 1.8-mm skin puncture was closed by Steri-Strips, as is usually done after Veress needle insertion. As per our institute's algorithm, the peritoneal sheet tear was closed if the defect was greater than 1 cm, and in all patients it was closed after cutting the inguino-scrotal sac.

In our institute, the mesh is not usually fixed to the pubic bone; its fixation is reserved only for procedures in which there is a risk of mesh slippage or in the case of a direct hernia. This strategy was adopted in 38.5% of the patients treated. Thanks to this particular technique, the mesh was simply rolled and inserted through the 11-mm trocar. If the technique includes the use of a single-port device [13], the latter must be removed for insertion of the mesh into the pre-peritoneal space.

To avoid perioperative complications, the strategy of being conservative with a vascular injury by partial vessel compression using the transumbilical atraumatic grasping forceps was adopted successfully in all patients [14, 15].

We observed a peritoneal sheet tear of 34.5%, treated (when necessary) by Veress needle insertion into the umbilical scar to evacuate the pneumoperitoneum and avoid the risk of conversion. Our data are high, but still in the range (0–47%) reported in the literature [14]. The peritoneal sheet tear was treated when the defect was greater than 1 cm to avoid the small bowel loop migration and subsequent intestinal occlusion. The peritoneal closure was performed by the transumbilical introduction of a preformed knot (straight endoloop) or by pre-peritoneal suture using the transumbilical, monocurved needle holder and the trocarless grasping forceps, or by intraperitoneal suture. This latter variant was performed at the end of the SILTEP with the introduction of the monocurved needle holder inside the peritoneal cavity together with the 11-mm trocar, closing the peritoneal gap by a PDS 2/0 intracorporeal suture with an extracorporeal knot. Finally, in case of a peritoneal access site sheet tear, a closure by open raphy was performed after its occurrence.

Due to the use of an only 11-mm rigid trocar, the final scar length after this SILTEP technique was 15 mm. This scar is similar to that left after use of the optical trocar

during CMTEP [16] and remains in contrast with the usual results after SIL, where a larger incision is necessary for the insertion of different port devices [17, 18].

Postoperative pain was evaluated using the VAS score every 6 h until the patient was discharged, but the pain was noted equally at the access site and hernia site. A similar result was reported after CMTEP [8, 16], but SILTEP seems to be less painful than CMTEP [19].

Among the early postoperative complications, both complications related to the access site and the hernia site occurred. Our incidence is between the range reported with SILTEP [9, 20] and CMTEP [11, 16]. The patient who was reoperated on for bleeding in the pre-peritoneal space was under anticoagulant therapy, and it is likely that the plan to resume medical therapy was initiated too early.

During follow-up, there was one asymptomatic small (5 mm) incisional hernia at the access site after 6 months that remained untreated. One patient presented with a recurrent inguinal hernia after 16 months and, at the time of SILTEP, the mesh was not fixed. We consider this recurrence to be an aspect of the learning curve more than an aspect of non-mesh fixation [21] because it occurred after 20 cases (10%) in the entire series.

Conclusion

Transumbilical SILTEP attracts interest because it permits placement of a large mesh through a final millimetric scar. The learning curve in CMTEP is mandatory. As per our institute's algorithm, the contraindications continue to be giant inguino-scrotal, incarcerated and recurrent inguinal hernias.

Compliance with ethical standards

Conflict of interest GD declares a conflict of interest not directly related to the submitted work (consultant for Karl Storz—Endoskope, Tuttlingen, Germany). LG declares no conflict of interest. MP declares no conflict of interest. GBC declares no conflict of interest. SS declares no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Zhu X, Cao H, Ma Y, Yuan A, Wu X, Miao Y, Guo S (2014) Totally extraperitoneal laparoscopic hernioplasty versus open extraperitoneal approach for inguinal hernia repair: a meta-analysis of outcomes of our current knowledge. Surgeon 12(2):94–105
2. Schouten N, Simmermacher RK, van Dalen T, Smakman N, Clevers GJ, Davids PH, Verleisdonk EJ, Burgmans JP (2013) Is there an end of the "learning curve" of endoscopic totally extraperitoneal (TEP) hernia repair? Surg Endosc 27(3):789–794
3. Weiss HG, Brunner W, Biebl MO, Schirnhofer J, Pimpl K, Mittermair C, Obrist C, Brunner E, Hell T (2014) Wound complications in 1145 consecutive transumbilical single-incision laparoscopic procedures. Ann Surg 259(1):89–95
4. Cugura JF, Kirac I, Kulis T, Janković J, Beslin MB (2008) First case of single incision laparoscopic surgery for totally extraperitoneal inguinal hernia repair. Acta Clin Croat 47(4):249–252
5. Kroh M, Rosenblatt S (2009) Single-port, laparoscopic cholecystectomy and inguinal hernia repair: first clinical report of a new device. J Laparoendosc Adv Surg Tech A 19(2):215–217
6. Hanna G, Hanna GB, Shimi SM, Cuschieri A (1998) Task performance in endoscopic surgery is influenced by location of the image display. Ann Surg 227:481–484
7. McCormack K, Wake B, Perez J, Fraser C, Cook J, McIntosh E, Vale L, Grant A (2005) Laparoscopic surgery for inguinal hernia repair: systematic review of effectiveness and economic evaluation. Health Technol Assess 9(14):1–203
8. Wijerathne S, Agarwal N, Ramzi A, Liem DH, Tan WB, Lomanto D (2016) Single-port versus conventional laparoscopic total extra-peritoneal inguinal hernia repair: a prospective, randomized, controlled clinical trial. Surg Endosc 30(4):1356–1363
9. Wakasugi M, Tei M, Anno K, Mikami T, Tsukada R, Koh M, Furukawa K, Suzuki Y, Masuzawa T, Kishi K, Tanemura M, Akamatsu H (2016) Single-incision totally extraperitoneal inguinal hernia repair as a teaching procedure: one center's experience of more than 300 procedures. Surg Today 46(9):1039–1044
10. Yang GP, Tung KL (2015) A comparative study of single incision versus conventional laparoscopic inguinal hernia repair. Hernia 19(3):401–405
11. Kim JH, Lee YS, Kim JJ, Park SM (2013) Single port laparoscopic totally extraperitoneal hernioplasty: a comparative study of short-term outcome with conventional laparoscopic totally extraperitoneal hernioplasty. World J Surg 37(4):746–751
12. Fuglestad MA, Waisbren SJ (2016) Two-port totally extraperitoneal inguinal hernia repair: a 10-year experience. Hernia 20(3):423–428
13. Romanelli JR, Earle DB (2009) Single-port laparoscopic surgery: an overview. Surg Endosc 23(7):1419–1427
14. Bittner R, Arregui ME, Bisgaard T, Dudai M, Ferzli GS, Fitzgibbons RJ, Fortelny RH, Klinge U, Kockerling F, Kuhry E, Kukleta J, Lomanto D, Misra MC, Montgomery A, Morales-Conde S, Reinpold W, Rosenberg J, Sauerland S, Schug-Pass C, Singh K, Timoney M, Weyhe D, Chowbey P (2011) Guidelines for laparoscopic (TAPP) and endoscopic (TEP) treatment of inguinal hernia [International Endohernia Society (IEHS)]. Surg Endosc 25(9):2773–2843
15. Chowbey P (2007) TEP. In: Fitzgibbons RJ, Schumpelik V (eds) Recurrent hernia. Prevention and treatment. Springer, Berlin, pp 274–279
16. Lo CW, Yang SS, Tsai YC, Hsieh CH, Chang SJ (2016) Comparison of laparoendoscopic single-site versus conventional multiple-port laparoscopic herniorrhaphy: a systemic review and meta-analysis. Hernia 20(1):21–32
17. Soon Y, Yip E, Onida S, Mangat H (2012) Single-port hernia repair: a prospective cohort of 102 patients. Hernia 16(4):393–396
18. Agrawal S, Shaw A, Soon Y (2010) Single-port laparoscopic totally extraperitoneal inguinal hernia repair with the TriPort system: initial experience. Surg Endosc 24(4):952–956

19. Tran H, Turingan I, Tran K, Zajkowska M, Lam V, Hawthorne W (2014) Potential benefits of single-port compared to multiport laparoscopic inguinal herniorraphy: a prospective randomized controlled study. Hernia 18(5):731–744
20. Kim JH, An CH, Lee YS, Kim HY, Lee JI (2015) Single incision laparoscopic totally extraperitoneal hernioplasty (SIL-TEP): experience of 512 procedures. Hernia 19(3):417–422
21. Claus CM, Rocha GM, Campos AC, Bonin EA, Dimbarre D, Loureiro MP, Coelho JC (2016) Prospective, randomized and controlled study of mesh displacement after laparoscopic inguinal repair: fixation versus no fixation of mesh. Surg Endosc 30(3):1134–1140