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Single incision laparoscopic totally preperitoneal hernioplasty (SIL-TPP) for bilateral inguinal hernia repair: initial experience

Qing Huang¹, Xiaojun Wang², Li Hu², Xionghua Xiang², Changlei Qi², Ting Fei² and Encheng Zhou^{2*}

Abstract

Objective The aim of this study was to introduce and assess the safety and feasibility of single incision laparoscopic totally preperitoneal hernioplasty (SIL-TPP) for bilateral inguinal hernia repair.

Method Forty-two SIL-TPP procedures for bilateral inguinal hernia repair were conducted from June 2018 to July 2022 at the First Affiliated Hospital of Ningbo University using standard laparoscopic instruments and a single-port device. Clinical data such as demographic intraoperative parameters and short-term postoperative outcomes were collected and analysed.

Results SIL-TPP was successful in 42 bilateral inguinal hernia patients, and no conversion occurred. Of these 42 patients, 38 were males and 4 were females. The average age was 57.4 ± 17 years. The participants' mean BMI was 22.67 ± 2.19 kg/m2 (range from 18.65 to 28.71 kg/m2). There were 4 types of bilateral hernias. The percentage of patients who underwent surgery before the SIL-TPP procedure in the same region was 21.43% (9/42). The mean operative time was 114 ± 34.24 min (range, 70-215 min). A total of 11 intraoperative complications occurred in 42 bilateral inguinal hernia patients, including unintentional peritoneum tears and hernia sac tears. No major complications occurred in the study. The postoperative complication rate was 2.38% (1/42). One patient experienced intestinal obstruction after the operation that resolved spontaneously without treatment. The surgical time in the SIL-TPP group decreased gradually as the number of operations increased. Moreover, the operation time trend decreased linearly (P < 0.0001, $R^2 = 0.42$).

Conclusion SIL-TPP is a safe and feasible procedure for treating bilateral inguinal hernias. The SIL-TPP procedure requires distinct skills and has specific advantages in treating bilateral hernias. Large-scale randomized controlled studies comparing SIL-TPP with conventional single-port and three-port laparoscopic TEP for bilateral inguinal hernia are needed to confirm these results.

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Keywords Totally preperitoneal hernioplasty (TPP), Totally extraperitoneal (TEP), Single incision laparoscopic totally preperitoneal hernioplasty (SIL-TPP), Single incision laparoscopic totally extraperitoneal hernioplasty (SIL-TEP), Bilateral inguinal hernia

Introduction

Inguinal hernia including bilateral Inguinal hernia is common disease. Methods for inguinal hernia repair have evolved from open surgery to minimally invasive approach. In addition, a amount of evidence has verified the efficiency, benefits and safety of simultaneous laparoscopic bilateral inguinal hernia repair [1]. International surgical society guidelines also suggested laparoscopic/ endoscopic approach is a recommended procedure to repair bilateral inguinal hernias simultaneous [2–4]. Less postoperative pain, faster recovery, less surgical trauma [5] are obvious advantages of laparoscopic repair. Now surgeons are trying to decreasing surgical trauma and improving cosmetology though reducing operating hole.

Since Cugura JF et al. reported the first case of laparoscopic totally extraperitoneal hernioplasty (TEP) via a single incision in 2008 [6], a number of studies have verified the safety and feasibility of single-incision laparoscopy totally extraperitoneal hernioplasty (SIL-TEP) [7, 8]. Evidence suggests that SIL-TEP is safe for bilateral inguinal hernia repair [8, 9]. However, the sample sizes in these studies were small. In addition, the overall aim of these study was to verify and show the safety and feasibility of SIL-TEP for unilateral inguinal hernia repair. There were few studies showed the feasibility and characteristics of SIL-TEP for bilateral inguinal hernias. In addition, tearing of the peritoneum is a common complication during surgery, and peritoneum tearing may further confine the SIL-TEP operation space. This disadvantage increases the risk of surgery and the recurrence rate [10, 11]. These disadvantages limit the usage of SIL-TEP for bilateral inguinal hernias. Considering that the abdominal wall consists of nine layers, we previously tried and succeeded performing single incision laparoscopic inguinal hernia repair totally in the preperitoneal space (PPS). In a result, the totally preperitoneal (TPP) concept was introduced. This procedure was named singleincision laparoscopic totally preperitoneal hernioplasty (SIL-TPP) [12]. Our results suggested that SIL-TPP was a safe and feasible procedure for inguinal hernia repair, especially indirect inguinal hernia repair [12, 13]. However, we did not show the characteristics of SIL-TPP for bilateral inguinal hernia. Our next article revealed that the TPP approach could overcome the disadvantages of TEP and make single incision laparoscopic inguinal hernia repair more feasible and safer for unilateral inguinal hernia repair when compared to SIL-TEP [14]. According to our experience, the SIL-TPP may also be safe and feasible for bilateral inguinal hernias even in the condition of peritoneal perforation. Besides, for the TPP approach is a new concept, more studies are needed to determine the feasibility and characteristics of the TPP approach for various abdominal hernias, which can be conducted via a single incision or multiple incisions.

Therefore, the aim of the current study was to evaluate the safety and feasibility of SIL-TPP for bilateral inguinal hernia repair and to share our experiences during surgery.

Methods

From June 2018 to July 2022, 42 bilateral inguinal hernia patients underwent SIL-TPP at the First Affiliated Hospital of Ningbo University. All patients were diagnosed in the outpatient clinic through physical examination and underwent ultrasonography or abdominal computed tomography (CT) examination if necessary. Since we conducted the SIL-TPP for bilateral inguinal, all bilateral inguinal hernia patients, including the first case, admitted to our department were considered for SIL-TPP hernia repair. The operation time was recorded according to the operation order thus analysing the operation time trend when the surgical number increasing. The exclusion criteria were as follows: (1) patients aged < 17 years and (2) patients with compromised cardiopulmonary disease or other disease who could not tolerate general anaesthesia. All the operations were performed by a single surgeon who was experienced in SIL-TEP.

The demographic data, clinical characteristics (sex, age, body mass index (BMI), previous lower abdominal surgery history and type of hernia), intraoperative findings (operation time, conversion, intraoperative complications), and postoperative complications (wound infection, mesh infection, haematoma, sanguineous apoplexy, seroma, stroke, urinary retention, urinary tract infection, hydrocele of testes, upper respiratory infection, visual analogue scale score (24 h), postoperative hospital days, recurrence) of the patients were prospectively recorded during the study. The surgical procedure was performed with conventional surgical instruments, including a conventional 30-degree laparoscope (STORZ, Germany) that was 10 mm in diameter and 45 cm in length. The single port used in our study was parallel to the port we previously used [12]. The operative time in the current study was calculated from the time of skin incision to the time of skin suturing. The inferior epigastric vessels, pubic bone, anterior superior spine, and Cooper's ligaments were identified as anatomic landmarks. Patients conventionally received postoperative intravenous



Fig. 1 The SIL-TPP procedure for bilateral inguinal hernia repair. (A) The layer between the adipose tissue and posterior sheath below the umbilicus was dissected at the beginning of the operation. (B) The midline PPS in the layer between the adipose tissue and posterior sheath was dissected. (C) The right Retzius space was separated, and the symphysis pubis was identified. (D) The right Bogros space was separated, and the inferior epigastric vessels were identified. (E) The left PPS in the layer between the adipose tissue and posterior sheath was separated. (F) The right Bogros space was separated.

cyclooxygenase-2 analgesics. Written informed consent was obtained from all the patients in the study. This study was approved by the Ethics Committee of the First Affiliated Hospital of Ningbo University.

SIL-TPP procedure for bilateral inguinal hernia repair

Patients were placed in the supine position with their arms adducted and underwent general endotracheal anaesthesia. The bladder was drained with a urethral catheter in case of an extended surgery and to maximize the working space. During the procedure, the patient was placed in the Trendelenburg position. The monitor was placed on the side of the hernia at the foot of the patient. The surgeon and assistant first stood on the offside of the simple hernia and repaired it. After the sac was isolated from the internal ring and the PPS was sufficiently dissected on the side of the simple hernia, the surgeon stood on the other side, and the monitor was relocated to perform conventional repair of the hernia on the other side.

A single 2.0–2.5 cm infraumbilical cambered preperitoneal incision was made following our previously described process [12]. After establishing the single incision, a multiple instrument access single-port device was inserted into the single preperitoneal incision. Preperitoneal carbon-dioxide insufflation was maintained at $10 \sim 13$ mmHg. A 30-degree laparoscope camera was inserted into the middle 10 mm of the channel. Conventional laparoscopic instruments, such as graspers and monopolar diathermy, were utilized for inguinal hernia repair. The PPS was dissected from the umbilical to the foot side. In addition, the dissection was located close to the posterior sheath, thus preventing dissection into the



Fig. 2 Large and flat PPS and mesh placement. (A) The large and flat right PPS after separation. (B) The large and flat left PPS after separation. (C) The large and flat PPS in SIL-TPP for bilateral inguinal hernia after separation.
(D) The left mesh was placed into the PPS. (E) The right mesh was placed into the PPS. (F) View of the 2 meshes placed into the PPS

mixed layer (Fig. 1A). After separating the infraumbilical PPS from the midline PPS (Fig. 1B), the soft Retzius space was separated (Fig. 1C). During separation of the Retzius space, the symphysis pubis and cord structures were identified. Then, the lateral PPS (Bogros space) of the simple hernia side was dissected towards the anterior superior iliac spine using an optical system. During the dissection of the Bogros space, the inferior epigastric vessels were identified (Fig. 1D). After completing the simple-side PPS dissection (Fig. 2A), the surgeon returned to the single incision, and dissected the connection between the peritoneum and posterior sheath closing to the sheath (Fig. 1E). Another lateral PPS (Bogros space) was also dissected towards the anterior superior iliac spine using an optical system (Figs. 1F and 2B). All potential inguinal hernia (direct hernia, indirect hernia and femoral hernia) were dissected to eliminate the potential omissive hernias. During separation, sac isolation or amputation (in the case of large scrotal hernias) was performed carefully for indirect hernia patients. For direct hernias, if the defect was large, the hernia sac was separated, and the defect was lessened by suturing the defect of the transversalis fascia to the surrounding tough tissue, thus preventing seroma formation. The round ligament of the uterus was preserved in female patients. The broken sac or peritoneum was closed by hemlock, endoloop, or suturing.

After separating the total PPS of the bilateral inguinal hernia (Fig. 2C), two meshes were placed into the PPS (Fig. 2D, E and F). The size of the mesh was 10 cm (craniocaudal) ×15 cm (latero-lateral). In current study, preshaped meshes were used (3D max light, BARD, USA). After the mesh was placed properly, it was carefully deflated for direct visualization. The posterior and anterior sheaths were sutured with absorbable 2–0 sutures, and the incision wound was sutured with absorbable 3–0 sutures.

Follow-up

Patients were contacted by telephone or outpatient follow-up. Every 3 months for the first year, every 6 months for the second year, and annually three after. Clinical evaluation was accepted during follow-up. Physical

Table 1	Patient	demogra	phics a	and her	nia	characteristics
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Variable	Data (n)
No. of patients	42
Sex	
Male	38
Female	4
Age (y)	57.4±17
BMI (kg/m2)	22.67 ± 2.19
Main type of hernias	
Bilateral direct	14
Bilateral indirect	11
One indirect and one direct or Femoral	14
Combined hernia	3
Previous lower abdominal surgery	
Radical resection of gastric cancer	1
Cesarean	1
Appendicectomy	3
One side open tension-free inguinal hernioplasty	3
Two side open tension-free inguinal hernioplasty	1

Values are presented as mean \pm standard deviation or number (%), Body mass index=BMI

examination was necessary. Ultrasonography or abdominal CT examination would be conducted when uncertain question was come across during the physical examination. The follow-up end point was fifth years after operation.

Statistical analysis

The following descriptive statistical methods were used in the present study: calculation of means and ranges for continuous variables and contingency tables for categorical variables. The data are shown as the mean \pm SD, number, or number (%).

Results

SIL-TPP was successful in 42 bilateral inguinal hernia patients, and no conversion occurred. Patient demographics and inguinal hernia characteristics are summarized in Table 1. Of the 42 patients, 38 were males and 4 were females. The average age of the participants was 57.4±17 years (range from 17 to 79 years). The participants' mean BMI was 22.67±2.19 kg/m2 (range from 18.65 to 28.71 kg/m2). Four types of bilateral hernias were identified during the operation: bilateral direct hernias (33.33%, 14/42), bilateral indirect hernias (26.19%, 11/42), one indirect hernia and one direct or femoral hernia (33.33%, 14/42), and combined hernias (7.14, 3/42), which was defined as one side that included 2 or more hernia types. One patient with a combined hernia had direct and femoral hernias on the right side and an indirect hernia on the left side. The second patient had a bilateral direct hernia combined with a femoral hernia on the left side. The third patient had from an indirect hernia and a direct and femoral hernia on the right side and a direct and femoral hernia on the left side. The percentage of patients who underwent surgery before the SIL-TPP procedure in the same region was 21.43% (9/42).

The mean operative time for bilateral inguinal hernias was 114 ± 34.24 min (range, 70–215 min) (Table 2). The operative times for the inguinal hernia subtypes were also analysed: the operative times were 113.57±30.20 min for bilateral direct hernias, 127.73±37.32 min for bilateral indirect hernias, 107.38±33.92 min for one indirect and one direct or femoral hernia, and 98.75±25.59 min for combined hernias. There were no cases of conversion in the current study. Any unintended event that influenced the operation was regarded as an intraoperative complication. A total of 11 intraoperative complications occurred in 42 bilateral inguinal hernia patients, for a rate of 26.19%. The intraoperative complications that occurred in the study were unintentional peritoneum tearing, hernia sac tears or intentional amputations of the hernia sac in cases of large scrotal hernias. When a hernia sac or peritoneum tearing exceeded 5 mm, the tearing was repaired with a clip or suture. No major bleeding,

Table 2 Operative data

Variable	Data
Operation time (min)	
Bilateral direct	113.57 ± 30.20
Bilateral indirect	127.73±37.32
One indirect and one direct or Femoral	107.38±33.92
Combined hernia	98.75 ± 25.59
Conversion	0 (0)
Intraoperative complication	26.19% (11/42)
Major bleeding	0 (0)
Bowel injury	0 (0)
Ductus deferens injury	0 (0)
Bladder injury	0 (0)
Internal spermatic vessel injury	0 (0)
Minor bleeding	0 (0)
Transection of vas deferens	0 (0)
Peritoneum or sac tearing	26.19% (11/42)

Values are presented as mean ± standard deviation or number (%)

Table 3	Short-term results
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Variable	Data	
Postoperative complication	2.38% (1/42)	
intestinal obstruction	2.38% (1/42)	
Mesh infection	0 (0)	
Wound infection	0 (0)	
Hematoma	0 (0)	
Seroma	0 (0)	
Sanguineous apoplexy/stroke	0 (0)	
Upper respiratory infection	0 (0)	
Urinary retention	0 (0)	
Urinary tract infection	0 (0)	
Hydrocele of testes	0 (0)	
Postoperative hospital day	2.57 ± 1.09	
Visual analogue scale score (24 h)	2.17 ± 0.77	
Recurrence (Until August 2023)	0	

Values are presented as mean ± standard deviation or number (%)

bladder injury, bowel injury, internal spermatic vessel injury or transection of the vas deferens occurred in the study.

Postoperative complications are shown in Table 3. One postoperative complication occurred (2.38% [1/42]). One patient experienced intestinal obstruction after the operation, which recovered spontaneously without treatment. For patients who underwent catheterization, no urinary retention occurred. The mean postoperative hospital stay was 2.57 ± 1.09 days. The mean postoperative pain score at 24 h was 2.17 ± 0.77 . There were no Hematoma and Seroma occurred during follow-up. Until August of 2023, there were no cases of recurrence during follow-up.

After SIL-TPP has verified it is a safe and feasible procedure for unilateral inguinal hernia repair, the procedure was also implemented for bilateral inguinal hernia. The operation time for bilateral hernias was recorded according to the order of operation, including the first case.



Fig. 3 The trend of operation times in our study. The operation time for SIL-TPP for bilateral inguinal hernia treatment decreased linearly (P < 0.0001, R^2 =0.42)

The operation time was recorded in this study to analyse trends. The operation time trend is shown in Fig. 3. The results revealed that the operation time for SIL-TPP for bilateral inguinal hernias decreased gradually as the number of operations increased. Moreover, the operation time trend decreased linearly (P<0.0001, R²=0.42).

Discussion

Bilateral inguinal hernia is a common condition. Several surgical procedures have been developed to repair inguinal hernias. Due to the benefits of laparoscopic surgery, such as less postoperative pain, faster recovery, and cosmetic benefits, international surgical society guidelines recommend the use of laparoscopic/endoscopic approaches via the TAPP or TEP technique to repair bilateral inguinal hernias [2–4]. Recently, single-incision surgery has become increasingly popular worldwide. In addition, evidence has shown that single-incision laparoscopic inguinal hernia repair (SIL-TEP) is a less invasive surgery with better cosmetic results than conventional laparoscopic TEP [15]. However, the TEP procedure has disadvantages during surgery, such as limited operation space and blocked views, which we have described before [12]. We previously attempted to perform inguinal repair in the preperitoneal space via a single incision, which was successful. Consequently, we introduced the total preperitoneal space (TPP) concept. The TPP approach could overcome the disadvantages encountered in TEP and make single-incision laparoscopic inguinal hernia repair more feasible [12]. In the present study, we demonstrated the feasibility of SIL-TPP for bilateral inguinal hernia repair.

Although this study did not compare SIL-TEP and conventional TEP for bilateral inguinal hernia repair, the results are valuable in determining the safety and feasibility of SIL-TPP for bilateral inguinal hernia repair when comparing our results with previous evidence. As expected, initial experience with this novel procedure is time-consuming. Interestingly, the operation time of our initial bilateral inguinal hernia repair procedure tended to be shorter than that of the initial procedures in prior SIL-TEP research [16–18]. Considering the learning curve, the operation time is expected to decrease with increasing experience, as reported in previous papers [11, 16, 19]. Moreover, the trend of the decrease in the operation time of SIL-TPP for bilateral inguinal hernias in our study was linear. Remarkably, the mean operation time for the last 10 patients in our study was 93 min (data not shown). The operation time was comparable to that of a surgeon experienced in SIL-TEP for unilateral inguinal hernia who has passed the learning curve [17]. In addition, all bilateral inguinal patients, including patients who had previously undergone lower abdominal surgery and experienced recurrence, were included in this study to reduce the influence of selection bias, thus reflecting the actual operation information in clinical practice. Hence, SIL-TPP is a feasible and less time-consuming procedure for bilateral inguinal hernia. In addition, we believe that the learning curve to master the SIL-TPP procedure is shorter than that for the SIL-TEP procedure for bilateral inguinal hernias.

During this study, the most common intraoperative complication was sac and peritoneum tearing. The peritoneum tear rate was 26.19%, which was comparable to that in previous studies [7]. Peritoneum tearing is a key factor that threatens the safety of the TEP operation [11, 20]. Although all previous studies revealed that SIL-TEP was technically feasible and safe, a confined operating space was the main difficulty encountered in the TEP procedure. After peritoneum tearing in the TEP procedure, the operating space was further confined to the pneumoperitoneum. Peritoneum tearing makes the operation more difficult and leads to an increase in the surgical failure rate [11]. Consequently, preventing peritoneum tearing is important in the TEP procedure. In addition, many efforts have been made to reduce peritoneum tearing, such as reducing the use of blunt incisions, experienced surgeons or careful patient selection [16, 20, 21]. The evidence suggested that the learning curve of SIL-TEP can be expected to increase in length and steepness [11]. Considering the natural disadvantages of the TEP procedure, operation conversions were common in previous studies [11, 22]. The failure rate and natural disadvantages of conventional TEP and SIL-TEP often cause surgeons to lack confidence in the operation, thus limiting its promotion and application. In our initial experience study, the rate of peritoneum tears was high. However, there was no operation failure or conversion. Remarkably, peritoneum tearing did not cause obvious surgical difficulty, as in our previous study [12], which is a significant advantage of the TPP procedure [12]. Moreover, peritoneum tearing is also expected to decrease with increasing experience.

Most surgeons agree that the limited surgical working space is natural and obvious difficulty in SIL-TEP [11, 16]. There is a consensus that the disadvantage of the TEP compared with the transabdominal preperitoneal hernioplasty (TAPP) procedure is the limited operation space [23]. The natural and obvious disadvantages of TEP increase the operation risk, difficulty and recurrence [10, 11]. Besides, this difficulty can not be addressed well with the help of robotic surgery [9]. Remarkably, in the current study, there were no complications other than peritoneum tearing or operation failure. In addition, the large working space of the SIL-TPP procedure observed in the study was explicit and sufficient. This characteristic is a unique advantage of the TPP procedure. For bilateral hernias, after finishing one PPS, it is difficult and timeconsuming to dissect the other PPS through the same skin incision in SIL-TEP. Choi, B. J. et al. used a balloon dissector, which was shown to be time-saving and effortless [16]. The anterior rectus sheath and posterior rectus sheath below the umbilicus in the linea alba are syncretic. In addition, the length of fusion is relatively long. Consequently, it is difficult and troublesome to dissect the contralateral space, as in SIL-TEP for bilateral inguinal hernias [16] and abdominal incisional hernias [24]. However, the abdominal wall PPS is a large soft space that has drawn the attention of many researchers [25]. It is easy to expand the PPS by separating the soft connection between the posterior sheath of the rectus abdominis and the peritoneum. Hence, we took advantage of the PPS in the current study and repaired bilateral inguinal hernias through the totally preperitoneal approach via a single incision. Our results revealed that SIL-TPP was a feasible procedure for treating bilateral inguinal hernias.

In the PPS, adipose tissue and fascia are the main components. According to our initial experience, dissection of the layer between the adipose tissue and posterior sheath below the umbilicus at the beginning of the operation is crucial, thus preventing it from entering the mixed layer. However, further studies are needed to clarify this phenomenon.

This study has the following limitations. First, it was a retrospective study. Second, the experience of SIL-TPP for bilateral inguinal hernia was not sufficient. Third, the number of patients enrolled in the study was small.

Conclusions

Overall, SIL-TPP is a feasible procedure for treating bilateral inguinal hernias. The SIL-TPP procedure possesses distinct advantages for accessing bilateral inguinal hernias, such as its large and simple space. The TPP

approach is worthy of further research to elucidate its feasibility for treating other abdominal hernias.

Abbreviations

TPP	Totally preperitoneal hernioplasty
TEP	totally extraperitoneal
SIL-TPP	Single incision laparoscopic totally preperitoneal hernioplasty
SIL-TEP	Single incision laparoscopic totally extraperitoneal hernioplasty
TAPP	transperitoneal hernioplasty
PPS	preperitoneal space
CT	Computed Tomography
BMI	Body Mass Index
ASA	American Society of Anesthesiologists
TAPP	transabdominal preperitoneal hernioplasty

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No.

Author contributions

Encheng Zhou, Qing Huang contributed to the study concept and design; Encheng Zhou, Ting Fei, Changlei Qi, were responsible for the acquisition of data; Encheng Zhou and Qing Huang, Li Hu drafted the manuscript; Encheng Zhou, Qing Huang, Xionghua Xiang, Li Hu performed the statistical analysis; Encheng Zhou, Xiaojun Wang conducted the material support and study supervision; All authors discussed the results and commented on the manuscript.

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study is an observational, retrospective research. Patients' written informed consent was obtained before operation. This study was approved by the Ethics Committee of The First Affiliated Hospital of Ningbo University (2024-123RS). Research involving human data was in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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