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A single surgeon's experience of 1000 consecutive transabdominal preperitoneal repair cases and measures to prevent recurrence

Tatsuya Tazaki, Masaru Sasaki, Mohei Kohyama, Yoichi Sugiyama, Takuro Yamaguchi, Shinya Takahashi¹, Atsushi Nakamitsu

Abstract

PURPOSE: In laparoscopic transabdominal preperitoneal repair (TAPP), the use of a larger mesh has been shown to reduce the rate of recurrence of hernia. However, recurrence may still be observed occasionally, especially in procedures performed by inexperienced surgeons. The purpose of this study was to clarify the learning curve of TAPP and to establish a procedure that precluded the possibility of recurrence.

MATERIALS AND METHODS: We analyzed the learning curve based on operative time, recurrence, and complication in a single surgeon's experience of 1,000 consecutive TAPP. In addition, by examining cases showing recurrence, techniques necessary to prevent recurrence were clarified.

RESULTS: The operative time stabilized after 60 cases and continued to reduce thereafter. Recurrence of nine hernias in eight patients within 1 year of surgery was observed up to the 482nd case. Recurrence or intraoperative complication was not confirmed since then. Recurrence after primary inguinal hernia repair presented as indirect hernia-type recurrence. The causes of recurrence were incomplete parietalization in indirect sliding hernia, insufficient dissection of the lateral dorsal side, and up-rolling mesh placement with the lateral dorsal side.

CONCLUSION: Recurrence can be prevented by sufficiently dissecting the preperitoneal space on the lateral dorsal side and taking care to avoid up-rolling of the mesh while it is being placed.

Keywords:

Groin hernia, learning curve, recurrence, transabdominal preperitoneal repair

Introduction

Compared with Lichtenstein repair,^[1] laparoscopic transabdominal preperitoneal repair (TAPP) and totally extraperitoneal repair (TEP) are associated with a lower incidence of wound infection, lower rate of hematoma formation and nerve injury, earlier return to normal activities or work, and fewer incidences of chronic postoperative inguinal pain (CPIP).^[2] Because of these advantages, TAPP and TEP are recommended by

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms. the International Guidelines for Groin Hernia Management (IGGHM).^[3] However, laparoscopic groin hernia repair is more difficult than Lichtenstein repair, and recurrence is more common in procedures performed by surgeons with experience of less than 250 cases.^[4]

Laparoscopic preperitoneal mesh repair, which can be considered to the prototype of TAPP, was first performed in the 1990s,^[5,6] and some results obtained at a single institution, including recurrence rate, were reported.^[7,8] However, in many of these

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Department of Surgery, JA Hiroshima General Hospital, ¹Department of Surgery, Graduate School of Biomedical and Health Sciences, Hiroshima University, Hiroshima, Japan

Address for correspondence:

Dr. Tatsuya Tazaki, Department of Surgery, JA Hiroshima General Hospital, 1-3-3, Jigozen, Hatsukaichi, Hiroshima 7388503, Japan. E-mail: tatsuyatazaki@ gmail.com

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reports, the mesh used was smaller than the one currently in use, a slit was placed in the mesh for the vas deferens and gonadal vessels, and the surgical procedure was not standardized. In 2011, the Guidelines of the International Endohernia Society (IEHS) recommended a mesh size of at least 15×10 cm to prevent recurrence.^[9] Since then, reports summarizing a single surgeon's experience from the introduction of TAPP have been rare,^[10,11] and those summarizing experience over 1,000 cases have been extremely rare.

In this report, we attempt to clarify the transition of outcomes of TAPP over 1,000 cases by a single surgeon, examine the learning curve based on operative time, recurrence, and complication, and report a technique that precludes the possibility of recurrence.

Materials and Methods

Clinical setting

The first author started performing TAPP in September 2013 and had completed 1,000 cases by September 2020. Findings over these 1,000 cases were retrospectively analyzed. The operations in 575 cases were performed by the first author, whereas those in the remaining 425 cases were mainly performed by senior surgical residents under the guidance of the first author.

Indications of TAPP

The anterior approach (the plug-and-patch technique,^[12] Lichtenstein repair,^[1] and tension repair) was selected when intra-abdominal adhesion was expected due to previous abdominal surgery or when general anesthesia surgery with pneumoperitoneum was not desirable due to cardiopulmonary or other diseases. However, in other cases, TAPP was performed. From October 2019, TEP was also performed for direct inguinal hernia, which was previously indicated for TAPP. As a result, our department recorded a total of 1,276 cases of groin hernia surgery during the study period, of which 1,000 involved TAPP, 32 involved TEP, 241 involved the anterior approach, and 3 involved other procedures.

Surgical technique

TAPP was performed using three ports: a 12 mm port was inserted through the umbilicus, and 5-mm ports were inserted into the left and right sides of the abdomen. In case of an indirect hernia, the sac was extracted or cut through. All adhesions between the hernia sac and cord structures were detached, also known as "parietalization." For a direct hernia, the sac was pulled out. In cases with a primary hernia, the entire myopectineal orifice was dissected and covered with a mesh, but in cases presenting with a recurrent hernia, the choice between covering the entire myopectineal orifice was based on the previous surgical procedure.^[13]

Up to the 78th case, a 13×9 cm Parietex[™] anatomical M-sized mesh (Medtronic, Minneapolis, MN, USA) was used in all cases. After the 79th case, in accordance with the guidelines of the IEHS,^[9] a 15×10 cm mesh was used in most cases. The meshes used during this period were mainly the Parietex[™] anatomical L-sized mesh, Versatex[™] monofilament mesh (Medtronic, Minneapolis, MN, USA), Bard[®] 3D Max[™] L-sized mesh (Bard Davol Inc., Cranston, RI, USA), and 15×10 cm TiMESH[®] mesh (Pfm Medical, Köln, Germany). In all cases, the mesh was fixed with a tacker. Fixation to the trapezoid of disaster,^[14] which causes neuropathy, was avoided. Absorbable tackers were used in most cases, but non-absorbable tackers were used in some repair procedures for recurrent inguinal hernias.



Figure 1: (A) Transition of operative time in unilateral cases performed by the first author. (B) Moving average curve in unilateral cases performed by the first author. The operative time stabilized in approximately 60 cases, and it continued to reduce thereafter

Data collection

Each patient's age, sex, height, weight, site and type of hernia, nature of the case (primary or recurrent), operative time, intraoperative or postoperative complications, CPIP, and hernia recurrence were recorded. According to IGGHM, CPIP is defined as " \geq bothersome moderate pain impacting daily activities lasting \geq 3 months postoperatively."^[3] The cause of recurrence was analyzed by reviewing the video of the initial surgery.

Statistical analysis

We used Student's *t*-test and Fisher's exact test to analyze parametric and non-parametric data, as appropriate. Statistical significance was set at P < 0.05. All statistical analyses were performed using EZR software (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R software (The R Foundation for Statistical Computing, Vienna, Austria). EZR is a modified version of R commander designed to add statistical functions frequently used in biostatistics.^[15]

Results

Operative time

Figure 1A shows the transition of operative time over 466 unilateral cases performed by the first author. The *x*-axis displays the case number, and the *y*-axis shows the operative time. Figure 1B shows the moving average curve converted into a graph. The *x*-axis displays groups of 20 consecutive patients, and the *y*-axis shows the mean operative time for each group of 20 patients. The operative time stabilized in approximately 60 cases, and it continued to reduce thereafter.

Hernia recurrence

Recurrence of nine hernias in eight patients was observed up to the 482nd case. No recurrence has been confirmed since then. As there was a definite difference in the recurrence rate, the period up to the 482nd case was defined as the learning period, and the period from the 483rd case was defined as the experienced period in this study. The first author performed 315 operations during the learning period and 260 operations during the experienced period.

In the initial period, after the introduction of TAPP, the postoperative strategy was to terminate the visit if the patient reported no problem in the outpatient department 1 week after the operation, and to readmit the patient to the hospital in case of prolonged pain or recurrence. Therefore, during the learning period, most patients completed one examination in the outpatient department 1 week after the operation. However, seven patients visited the department due to recurrence between 6 months and 1 year after the operation. After reviewing all surgery videos, one patient who was judged to have undergone inappropriate surgery in which parietalization was not completed was urged to receive a medical examination by phone and was subsequently confirmed to show recurrence. In contrast, in the experienced period, patients visited the hospital 1 week, 3 months, and 1 year after the operation, and the presence or absence of pain and recurrence was evaluated during these visits. Of the 518 patients treated in the experienced period, 484 patients (93.4%) were evaluated at 3 months after surgery and 430 (83.0%) were evaluated 1 year after surgery, but none showed recurrence. Seventy of the 88 patients who did not undergo a medical examination 1 year after the operation were contacted by telephone, and no recurrence or chronic pain was reported by these patients. Seven deaths were confirmed. Thus, the outcomes for 500 of 518 patients in the experienced period (96.5%) were confirmed 1 year after surgery. No patient visited the hospital because of recurrence >1 year after the operation.

Of the nine recurrent hernias in eight patients during the learning period, seven hernias in six patients recurred after TAPP for primary indirect inguinal hernia. The results are presented in Table 1. A 15×10 cm mesh was used in all cases. Cases 1–4 involved indirect sliding hernias. These hernias often show a high degree of adhesion between the hernia sac and cord structure. Therefore, advanced techniques are required to detach adhesions without causing damage to the cord structure.

Table 1: Recurrent cases after pri	mary inguinal hernia rep	Dair
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Case no.	Number of cases since introduction	Gender	Site of lesion	Findings at the initial surgery	Cause of recurrence
1	362	Male	Left	Indirect sliding hernia	Incomplete parietalization
2	470	Male	Right	Indirect sliding hernia	Incomplete parietalization
3	159	Male	Left	Indirect sliding hernia	Insufficient dissecition on the dorsal side
4	412	Male	Bilateral	Indirect sliding hernia	Hematoma lifted mesh?
5	260	Male	Right	Indirect hernia	Dorsal side of the mesh was up-rolling
6	482	Male	Right	Indirect hernia	Dorsal side of the mesh was up-rolling



Figure 2: Case 1: (A) Left indirect sliding hernia. (B) Dissection of the preperitoneal space is performed without detachment of all adhesions between the hernia sac and the cord structures, known as "parietalization" (white arrow). (C) As parietalization is not completed, the mesh can be easily flipped by lifting the dorsal peritoneum



Figure 3: Case 3: (A) Left indirect sliding hernia. The preperitoneal space must be detached to the black dotted line on the dorsal side, but recurrence occurred because it was detached only to the black solid line. (B) Detachment was performed only to the ventral side of the sigmoid colon (black arrow). (C) The mesh was placed superior to the sigmoid colon (black arrow). In addition, the dorsal side of the mesh was up-rolled. Originally, the mesh was deployed on the dorsal side of the sigmoid colon. (D) Laparoscopic findings showed recurrence, with the sigmoid colon slipping out due to mesh contraction or mesh flipping



Figure 4: Case 4: (A) After completion of preperitoneal dissection for right indirect sliding hernia. The dissection appeared to be sufficient. (B) Parietex[™] anatomical mesh size L was deployed, but the type of recurrence that slides together with the mesh occurred 6 months later

In cases 1 and 2, recurrence occurred because the mesh was placed without completing parietalization. This was an obvious technical error. Figure 2 shows photographs f case 1 at the time of the initial surgery.

Figure 3 shows photographs of case 3 at the time of the initial surgery. An indirect sliding hernia requires a mesh to be deployed between the sliding organ and the extraperitoneal fascia. When the sliding organ is the sigmoid colon, a mesh should be placed on the dorsal side of the sigmoid colon [Figure 3A, black dotted line]. However, in this case, the distance of parietalization is short [Figure 3A, black solid line], and the mesh was placed superior to the sigmoid colon [Figure 3C]. Recurrence occurred 1 year later, and laparoscopic findings at the time of recurrence showed that the sigmoid colon had slipped out due to mesh contraction or mesh flipping [Figure 3D]. At the time of the initial surgery, we thought that an overlap of approximately 3 cm on the dorsal side of the hernia orifice would be appropriate, and we did not account for mesh deployment in indirect sliding hernia.

Case 4 involved an indirect sliding hernia extending to the scrotum. The dissection appeared to be sufficient, but recurrence was observed as an indirect hernia 6 months later [Figure 4]. The mesh may have been lifted due to a postoperative hematoma, but this is unclear. In contrast, cases 5 and 6 did not involve indirect sliding hernias. The cause of recurrence in these cases was probably the raised placement of the dorsal side of the mesh, with the mesh being rolled up subsequently because the cecum had pushed the mesh early after surgery [Figure 5]. Sufficient parietalization to allow mesh placement without up-rolling is necessary to prevent recurrence, even when the case does not involve an indirect sliding hernia.

Recurrence after TAPP for recurrent inguinal hernia was observed in two cases, which were also recorded during the learning period. Both cases showed direct herniatype recurrence, which has already been reported.^[13] The cause of recurrence was insufficient dissection in the Retzius cavity. As a result of examining recurrence cases, we decided to perform the following procedures to prevent further recurrence.

- For indirect sliding hernias, the continuity of retroperitoneal fat, which is a sliding component, was cut off [Figure 6A] (white arrow) to prevent recurrence attributable to sliding with the mesh.
- In all cases, even those not involving an indirect sliding hernia, a mesh with a vertical width of 10 cm was placed taking care to avoid up-rolling by ensuring sufficient preperitoneal cavity detachment on the lateral dorsal side [Figure 6B]. In the procedures performed on the left side, the mesh was placed on the dorsal side of the sigmoid colon [Figure 6C].

These measures helped prevent recurrence in subsequent cases.

Complications

Table 2 shows the clinical characteristics of the 1,000 patients who underwent TAPP. The first 482 cases constituted the learning period group, and the remaining 518 cases formed the experienced period group. The two groups showed no significant differences in patient's age, sex, height, weight, side of lesion, type of hernia, and percentage of primary or recurrent hernia.



Figure 5: Case 5: The lateral dorsal side of the mesh is unfolded in the up-rolling state (black arrow)



Figure 6: Surgical procedure in the experienced period. (A) The continuity of retroperitoneal fat, which is a sliding component, is cut off (white arrow), and sufficient detachment to the dorsal side is performed. (B) The lateral dorsal side of the mesh is placed without up-rolling (white arrow). (C) A mesh (white arrow) is placed on the dorsal side of the sigmoid colon

Table	2:	Patient	characteristics
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	Learning period (n = 482)	Experienced period (n = 518)	P-value
Cases (hernias)	482 (599 hernia)	518 (625 hernia)	
Age (years) ^a	69.6±13.5	68.7±12.8	0.317
Sex (male/female)	415/67	456/62	0.396
Height (cm)ª	162.0±8.6	162.7±8.5	0.433
Weight (kg)ª	59.5±10.2	60.7±10.1	0.206
Side of lesion			
Unilateral/bailateral (n)	365/117	412/106	0.171
Right/left (unilateral case)	204/161	225/187	0.773
Type of hernia (n)			0.428
Indirect	385	421	
Direct	141	123	
Femoral	20	23	
Combined	53	58	
Primary/recurrent (n)	569/30	586/39	0.387

^aValues are mean ± SD

Table 3: Intraoperative and postoperative complications

	Learning period (n = 482)	Experienced period (n = 518)	P-value
Intraoperative complications (n)			
Intestinal injury	1	0	0.482
Bleeding (>100 mL)ª	1	0	0.482
Postoperative complications (n)			
Hematoma/extensive subcutaneous bleeding	9	1	0.0197
Superficial surgical site infection	1	0	0.482
Delayed mesh infection	1	0	0.482
Small bowel obstruction	1	0	0.482
Incisional hernia	3	1	0.357
Chronic postoperative inguinal pain (n)	3	5	0.727
Hernia recurrence (n)	9	0	<0.01

^aDue to inferior epigastric artery injury

Table 3 presents the surgical and postoperative complications. Intraoperative complications were confirmed only during the learning period. A small intestinal injury was observed in one case, which occurred at the time of insertion of the first port after gastrectomy. In addition, one case of small bowel obstruction was observed during the learning period, which occurred as a result of peritoneal suturing under tension in a patient showing recurrence after the use of the Kugel technique.^[16] During the learning period, when the author was less accustomed to the procedure, some challenging cases that were not originally indicated for TAPP were encountered, such as cases in which intra-abdominal adhesions were expected and cases showing recurrence after preperitoneal mesh repair. Since then, the anterior approach has been selected for such difficult cases. Regarding postoperative complications, cases showing hematoma/extensive subcutaneous bleeding decreased significantly in the experienced period, but no significant difference was observed in the occurrence of other complications. The incidence of CPIP was not significantly different (three cases during the learning

period and five cases during the experienced period; P = 0.727). However, during the learning period, most patients completed an examination 1 week after the operation, and many patients were not examined 3 months after the operation, so more patients who had undergone TAPP during the learning period may have experienced CPIP subsequently.

Discussion

The rate of recurrence after TAPP varied across studies. In a registry-based, propensity score-matched comparison of 57,906 patients in the Herniamed Hernia Registry reported in 2019, the recurrence rate after TAPP in cases with a 1-year follow-up period was approximately 1.0%, and there was no significant difference between Lichtenstein repair and TEP.^[17] Therefore, a recurrence rate of 1% at the 1-year follow-up is currently targeted by surgeons performing TAPP. However, another report describing the findings for a large, retrospective series showed a 5% recurrence rate with the 11×6 cm mesh and 0.16% recurrence rate with the 15×10 cm mesh.^[18] may be associated with higher recurrence rates.^[19] On the basis of these reports, IEHS guidelines recommend a mesh size of at least 15 × 10 cm even in small patients.^[9] In addition, animal data have suggested that a minimum mesh overlap of 3 cm is essential to prevent mesh protrusion through the hernia defect, which will result in recurrence.^[20]

In our report, in the first 482 cases, nine hernias recurred in eight patients, representing a relatively large number of recurrences. Seven hernias in six patients with a primary indirect inguinal hernia occurred despite TAPP with a 15×10 cm mesh. Thus, factors other than mesh size may also play important roles in preventing recurrence. Lowham et al.^[21] advocated the development of measures for preventing recurrence by reviewing videos of past cases showing recurrence; one such measure is the careful placement of the inferior edge of the prosthesis flatly against the pelvic floor. The recurrences in our cases are thought to have occurred due to a lack of consideration for this technique. As TAPP has now become a standard procedure and the need for a large mesh has been identified, the most important steps to prevent recurrence are to avoid up-rolling of the dorsal side of the mesh, which cannot be tacked and fixed due to the presence of the trapezoid of disaster^[14] and to prevent recurrence caused by sliding together with the mesh in indirect sliding hernia. Bittner and Schwarz^[22] stated that parietalization should be performed at least 4-5 cm inferior to the iliopubic tract to avoid mesh elevation. In addition, we believe that the ensuring discontinuity of the retroperitoneal fat, which is a sliding organ, and placement of a mesh on the dorsal side of the cecum and sigmoid colon prevented further cases of recurrence.

The learning curve for TAPP has been described in multiple previous studies. Although one study based on an analysis of the operative time suggested that the learning curve was overcome after 75 cases,^[11] other studies considering recurrence and complications reported that the rates of complications and recurrences decreased significantly after 250^[3] or 300 repairs.^[23,24] In our study, we analyzed the learning curve based on operative time, recurrence, and complication. The operative time stabilized after 60 cases, but since it continued to reduce thereafter, the learning curve was not clear. Up to the 482nd case, >1% of recurrences were observed, so we considered this as the learning period. Cases showing Clavien-Dindo class III or higher complications, such as small bowel injury and small bowel obstruction, were also observed during the learning period. Bittner and Schwarz^[22] reviewed >15,000 TAPP cases. During the first 600 cases when the technique was learned, the complication rate was 9.3%, reoperation rate 1.3%, and the recurrence rate 4.8%. For the following

series, the corresponding numbers were 2.6%, 0.4%, and 0.4%, respectively. Similarly, we would like to continue TAPP with few recurrences and complications.

The present study has several limitations: First, this study was conducted retrospectively and based on only one surgeon's experience. Thus, our results may not be reproducible for other surgeons. Secondly, recurrence within 1 year after surgery was the primary outcome, and although 83% of the patients in the experienced period could be examined 1 year after surgery, long-term outpatient follow-up was not performed during the learning period. Moreover, although recurrence >1 year after surgery was not observed, Peitsch^[25] recommended that quantitative data on hernia recurrence rates after TAPP should be collected in postoperative follow-up studies >10 years because 4% of recurrences develop >10 years after surgery. Despite these limitations, we found that recurrence within 1 year after TAPP can be prevented by sufficient parietalization and dissection on the lateral dorsal side and taking care to avoid up-rolling of the mesh.

In conclusion, up to the 482nd case, >1% of recurrences and intraoperative complications were observed, so we considered this as the learning period. In TAPP, sufficient parietalization and dissection on the lateral dorsal side to allow the placement of a mesh with a vertical width of 10 cm without up-turning and placement of a mesh on the dorsal side of the sigmoid colon in left groin hernia can help prevent recurrence. The learning period may be shortened by performing the procedure with these considerations under the guidance of a well-experienced surgeon.

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Nil.

Conflicts of interest

The authors declare no conflicts of interest associated with this study.

Ethical statements

This study was approved by the Ethics Committee of the Institution (20–65) and conformed to the provisions of the Declaration of Helsinki.

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