—**Original**—

Preoperative Subcutaneous Fat is an Useful Indicator for Learning Totally Extraperitoneal Repair

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Background: Totally extraperitoneal (TEP) repair is a recommended procedure for inguinal hernia repair in European hernia guidelines. However, technical challenges have limited its uptake in Japan, where transabdominal preperitoneal (TAPP) repair is more common. We evaluated the association of preoperative subcutaneous fat area (preSFA) with surgical outcomes and identified factors associated with the difficulty of TEP repair.

Methods: Clinical data from 62 patients undergoing TEP repair were collected retrospectively. Using the median for the preoperative subcutaneous fat index (preSFI; 45.9 cm^2/m^2), we classified patients as having a high SFI (HSFI) (n=31) and low SFI (LSFI) (n=31). Surgical outcomes and perioperative complications were then compared between these groups. Additionally, TEP repair was divided into five phases (e.g., Phase 1: dissection of the caudal side of the preperitoneal space), and operative time was measured during each phase. Phase 1 was divided into two sub-phases (1A: insertion of the first port, 1B: reaching Cooper's ligament).

Results: Operative time was longer (133 min vs 111 min, $P = 0.028$) and the peritoneal injury rate was higher (35.5% vs 9.7%, $P = 0.015$) for the HSFI patients. Furthermore, operative time for HSFI patients was significantly longer during Phase 1 ($P = 0.014$) and Phase 1A ($P = 0.022$).

Conclusions: preSFA was associated with a higher peritoneal injury rate and longer operative time in HSFI patients, suggesting that the presence of abundant subcutaneous fat increases the difficulty of TEP repair. (J Nippon Med Sch 2023; 90: 33–40)

Key words: anatomical landmark, ImageJ, inguinal hernia, subcutaneous fat, totally extraperitoneal (TEP) repair

Introduction

European Hernia Society guidelines recommend totally extraperitoneal (TEP) repair, transabdominal preperitoneal (TAPP) repair, or Lichtenstein repair for treatment of adult inguinal hernia[1]. A questionnaire survey in Japan for the period from 1990 through 2019 indicated that 436,559 adult inguinal hernia repairs were performed[2]. However, TEP repair was performed in only 31,536 cases (7.2%), while TAPP repair was performed in 96,436 cases (22.1%), indicating that uptake is lower for TEP repair, perhaps because of the long, steep learning curve for TEP repair, mastery of which requires between 50 and 100 or more procedures, according to EHS guidelines[1,3,4].

Because laparoscopic surgeries are technically difficult in obese patients, preoperative subcutaneous fat area (preSFA), as determined by computed tomography (CT) scanning and ultrasonography, has been used to evaluate surgical outcomes. Several studies reported correlations of preSFA with surgical outcomes (operative time, bleeding, and duration of postoperative hospital stay) in laparoscopic gastrectomy and colon surgery[5,6]. Furthermore, operative time in TEP repair was positively correlated

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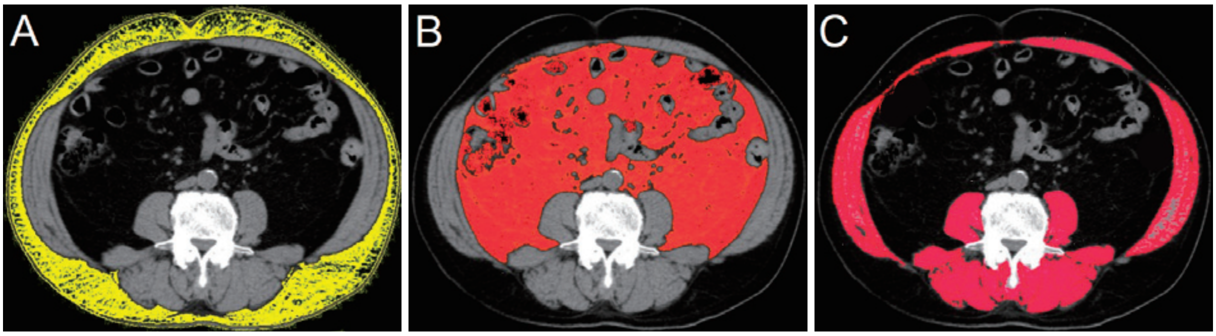

Fig. 1 Cross-sectional computed tomographic images at the third lumbar vertebra level. (**A**) Subcutaneous fat area and (**B**) visceral fat area were quantified and expressed as −190 to −30 HU. (**C**) Skeletal muscle area, including the psoas, erector spinae, quadratus lumborum, transversus abdominis, external and internal obliques, and rectus abdominis, was quantified and expressed as −29 to 150 HU. HU, Hounsfield units.

with body mass index (BMI)[7]. However, it is unclear whether such correlations with preSFA exist for endoscopic hernia repair.

This study examined associations of preSFA with surgical outcome and perioperative complications in TEP repair and identified factors associated with the difficulty of TEP repair, which can be applied to trainees who started the TEP repair acquisition.

Materials and Methods

Patients

During the period from June 2017 through December 2019, 214 adult patients underwent inguinal hernia repairs at our institution. After excluding 127 conventional/TAPP repair cases, 19 incarceration cases, 5 bilateral cases, and one case without preoperative CT scans, clinical data from 62 patients were included in the analysis. Using the median preoperative subcutaneous fat index (preSFI: 45.9 cm^2/m^2), we classified patients as having a high SFI (HSFI; preSFI >45.9 cm^2/m^2; n=31) and low SFI (LSFI; preSFI <45.9 cm^2/m^2; n=31). The surgical outcomes for these groups were then analyzed retrospectively.

The study protocol was approved by the institutional review board of Tokyo Women's Medical University (Approval No. 5492). All procedures were conducted in accordance with guidelines published by the European Hernia Society and Japan Hernia Society. The requirement for informed consent was waived by the Tokyo Women's Medical University Ethics Committee. Instead, opt-out consent was approved by the committee and obtained on our websites, where permission was requested for use of participants' personal information in this study.

Evaluations

Hernia type was classified by using the Nyhus classification[8]. Surgical outcome was evaluated by examining operative time, blood loss, intraoperative complications, and postoperative complications of Grade 1 or higher according to the Clavien-Dindo classification[9]. The TEP procedure was divided into five phases, as described below, and operative time was measured for each phase.

Measurement of Body Composition

All preoperative CT scans were obtained with a 64-row or 16-row multidetector CT scanner (GE Healthcare, Hino, Japan), 1 to 2 months before surgery. Digital Imaging and Communication in Medicine images were imported into a computer, and ImageJ software ver. 1.52i (National Institutes of Health, Bethesda, MD, USA) was used to measure SFA and visceral fat area (VFA) on a cross-sectional plain CT scan at the third lumber vertebra (L3) level. SFA and VFA were identified and expressed as −190 to −30 Hounsfield units (HU) (**Fig. 1A, 1B**)[10,11]. Similarly, skeletal muscle mass, including the psoas, erector spinae, quadratus lumborum, transversus abdominis, external and internal obliques, and rectus abdominis, was identified and expressed as −29 to 150 HU (**Fig. 1C**)[12]. SFA, VFA, and skeletal muscle mass were normalized as the subcutaneous fat index (SFI, cm^2/m^2), visceral fat index (VFI, cm^2/m^2), and skeletal muscle index (cm^2/m^2) by dividing the square of the patient's height in meters.

Operation

Operations were performed by three surgeons who had each performed 15 or fewer TEP repairs before the study. Each surgeon performed 15 to 25 TEP repairs during the study period. A 12-mm camera port was inserted into the preperitoneal space via a longitudinal incision on the lower aspect of the umbilicus. The TEP procedure was divided into five phases, as follows.

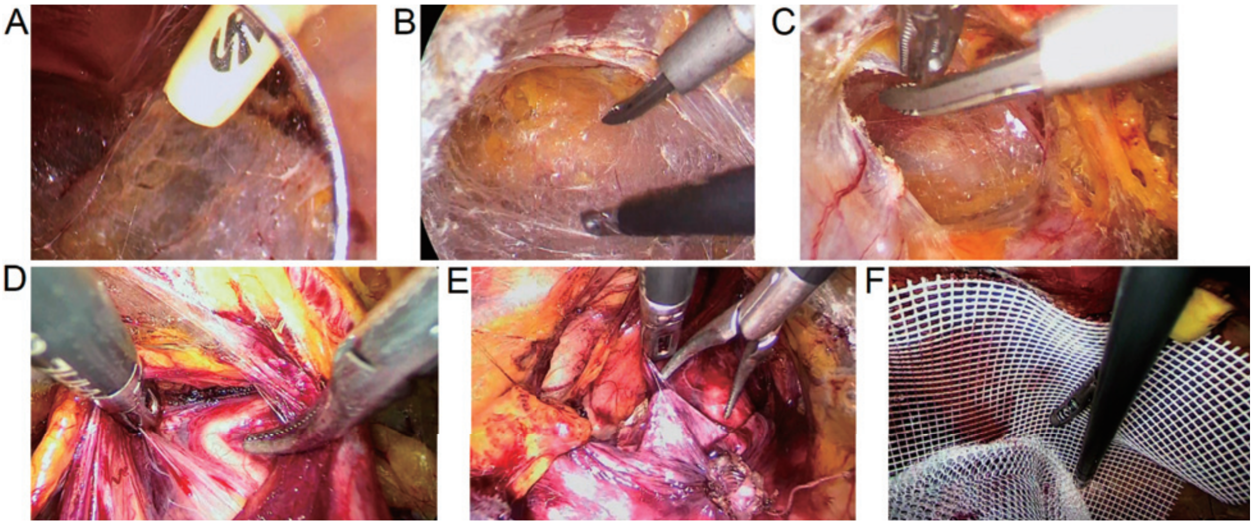

Fig. 2 Dissection of the caudal side of the preperitoneal space (Phase 1). (**A**) Insertion of the first port (Phase 1A). (**B**) Reaching Cooper's ligament (Phase 1B). (**C**) Dissection of the lateral side of the preperitoneal space (Phase 2). (**D**) Dissection and transection of the hernia sac (Phase 3). (**E**) Dissection of the dorsal side of the preperitoneal space (Phase 4). (**F**) Mesh placement and fixation (Phase 5).

Phase 1: A 5-mm working port was inserted directly below the first trocar (**Fig. 2A**). The caudal side of the peritoneal space was dissected toward Cooper's ligament. An additional 5-mm working port was inserted at three finger widths above the pubic symphysis. The inferior epigastric vessels were confirmed as a landmark (**Fig. 2B**).

Phase 2: The lateral side of the preperitoneal space was dissected until the anterior superior iliac spine. The peritoneal edge was defined as a landmark (**Fig. 2C**). The lateral edge of the arcuate line was partially incised to secure space for mesh placement.

Phase 3: The indirect hernia sac was dissected by ligation using 2-0 Silk (Ethicon, NJ, USA) and transection of the sac (**Fig. 2D**).

Phase 4: The dorsal side of the preperitoneal space was dissected, and parietalization of the testicular vessels and spermatic cord (round ligament for female patients) was performed (**Fig. 2E**).

Phase 5: For mesh placement, Parietex Anatomical Mesh (Medtronic, Dublin, Ireland) was placed on the myopectineal orifice (**Fig. 2F**). The mesh was fixed on Cooper's ligament and medial/lateral side of the inferior epigastric vessels with an AbsorbaTack (Medtronic). A Sonicbeat (Olympus, Tokyo, Japan) device with an ultrasonic generator (USG-400; Olympus) was the main ultrasonically activated device in this study. In patients with severe peritoneal injury or adhesions that could not be treated with TEP repair, the procedure was converted to TAPP repair.

Statistical Analysis

Pearson's correlation coefficient (R) was used to analyze the relationship between operative time/blood loss and BMI/SFI/VFI. Continuous data are presented as median or mean ± SD. Continuous variables were nonparametrically analyzed with the Mann-Whitney *U* test. Categorical variables were compared with the χ^2 test, when appropriate. Correlations between continuous variables were assessed by using Pearson correlation coefficients. A *P* value less than 0.05 was considered to indicate statistical significance. All statistical data were generated with JMP Pro 15 (SAS Institute, Cary, NC, USA).

Results

Correlation Between Obesity Factors and Surgical Difficulty

To clarify the obesity factors related to surgical difficulty, correlation between BMI/SFI/VFI and operative time/blood loss was analyzed. Compared to BMI (R = 0.281, *P* =0.027, **Fig. 3A**), and the most correlated obesity factor with operative time was SFI (R =0.459, *P* <0.001, **Fig. 3B**), and VFI (R =0.213, *P* =0.097, **Fig. 3C**). There was no significant correlation between BMI/SFI/VFI and blood loss (data not shown).

Patient Characteristics

The preoperative characteristics of HSFI and LSFI patients are shown in **Table 1**. Body weight (*P* =0.0003), BMI (*P* <0.0001), SFI (*P* <0.0001), and visceral fat index (*P* <0.0001) were significantly higher in the HSFI group than in the LSFI group. Age, sex, and skeletal muscle

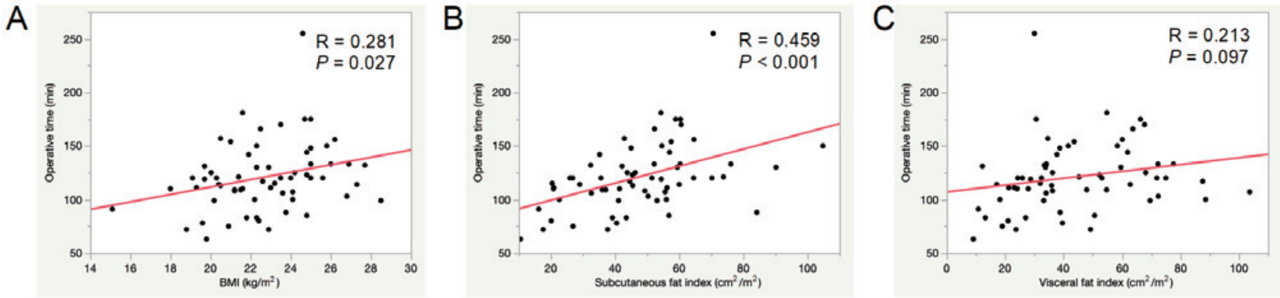

Fig. 3 Correlation between obesity factors and surgical difficulty. Correlation between operative time and (**A**) BMI, (**B**) subcutaneous fat index, and (**C**) visceral fat index.

Table 1 Patient characteristics between the groups

	HSFI (n=31)	LSFI (n=31)	*P* value
Age, median (range)	70 (27-88)	71 (27-90)	0.778
Sex, n (%)			
Male	27 (87.1)	27 (87.1)	1.000
Female	4 (12.9)	4 (12.9)	
Body weight, kg (±SD)	65.3±7.7	56.4±10.4	0.0003
Body mass index, kg/m^2 (±SD)	24.1±2.1	21.3±2.4	<0.0001
Skeletal muscle mass index, cm^2/m^2 (±SD)	51.1±6.1	49.5±9.0	0.627
Subcutaneous fat area index, cm^2/m^2 (±SD)	57.8±19.8	29.9±12.0	<0.0001
Visceral fat area index, cm^2/m^2 (±SD)	56.2±19.3	31.5±15.8	<0.0001
Comorbidity, n (%)			
Contralateral inguinal hernia repair	6 (19.4)	4 (12.9)	0.490
Lower abdominal surgery	5 (16.1)	4 (12.9)	0.719
Cardiovascular	17 (54.8)	8 (25.8)	0.020
Diabetes	5 (16.1)	2 (6.5)	0.229
Respiratory	2 (6.5)	2 (6.5)	1.000
Celebral	2 (6.5)	2 (6.5)	1.000
Location of hernia, n (%)			0.075
Right	11 (35.5)	18 (58.1)	
Left	20 (64.5)	13 (41.9)	
Type of hernia*, n (%)			0.245
I	19 (61.3)	23 (74.2)	
II	5 (16.1)	5 (16.1)	
IIIa	7 (22.6)	2 (6.5)	
IIIc	0 (0.0)	1 (3.2)	

*Nyhus classification

mass index did not significantly differ between groups. Analysis of comorbidities revealed that prevalence of cardiovascular disease was significantly higher (P =0.02) in HSFI patients but that other comorbidities did not significantly differ between groups. Additionally, hernia location and type did not significantly differ between groups.

Surgical Outcomes

Operative time was significantly longer (133 min vs 111 min, P = 0.028) and the rate of peritoneal injury was significantly higher (35.5% vs 9.7%, P = 0.015) in HSFI patients. Three HSFI cases and no LSFI cases (P = 0.076) were converted to TAPP repair. There was no significant difference in blood loss or other perioperative complications (**Table 2**). Operative time for HSFI patients was significantly longer for Phase 1 (20.5 min vs 16 min, P = 0.014) and Phase 1A (6 min vs 3 min, P = 0.022) but did not differ significantly for Phase 1B or the other phases (**Table 3**). We attempted to identify the common site of peritoneal injury and conversion to TAPP repair during each phase, but there was no significant difference in relation to phase (**Table 4**).

Table 2 Surgical outcomes between the groups

	HSFI (n=31)	LSFI (n=31)	*P* value
Operative time, median (range)	133 (73-255)	111 (63-167)	0.028
Blood loss, mL (±SD)	2.4±1.5	2.2±1.4	0.605
Intraoperative complications, n (%)			
Peritoneal injury	11 (35.5)	3 (9.7)	0.015
Conversion to TAPP	3 (7.5)	0 (0.0)	0.076
Bleeding	0 (0.0)	0 (0.0)	1.000
Postoperative complications, n (%)			
Seroma*	3 (9.7)	4 (12.9)	0.688
Surgical site infection*	3 (9.7)	0 (0.0)	0.076
Chronic pain	0 (0.0)	0 (0.0)	1.000
Postoperative recurrence	0 (0.0)	0 (0.0)	1.000

*Clavien-Dindo Classification Grade I

Table 3 Operative time during the surgical proccess

	HSFI (n=31)	LSFI (n=31)	*P* value
Operative time, median (range)			
Phase 1	20.5 (6-45)	16 (9-24)	0.014
1A	6 (1-22)	3 (1-11)	0.022
1B	13.5 (5-31)	12 (0-17)	0.217
Phase 2	15.5 (6-43)	13 (3-44)	0.525
Phase 3	34 (9-93)	31 (7-81)	0.727
Phase 4	13.5 (5-47)	13 (4-28)	0.604
Phase 5	12.5 (7-24)	10 (7-20)	0.221
Total	133 (73-255)	111 (63-167)	0.028

Table 4 Intraoperative complications during the surgical phase

	Peritoneal injury			Conversion		
	HSFI	LSFI	*P* value	HSFI	LSFI	*P* value
Phase 1	2 (18.2)	2 (66.7)		2 (66.7)	0 (0.0)	
Phase 2	3 (27.3)	0 (0.0)		1 (33.3)	0 (0.0)	
Phase 3	4 (36.4)	1 (33.3)		0 (0.0)	0 (0.0)	
Phase 4	2 (18.2)	0 (0.0)		0 (0.0)	0 (0.0)	
Phase 5	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	
Total	11	3	0.346	3	0	NA

Values in parentheses are percentages

Discussion

In this study, patients with more subcutaneous fat preoperatively had a higher peritoneal injury rate and longer operative time, especially during dissection of the caudal side of the preperitoneal space.

Compared with open inguinal hernia repair, TEP repair is associated with less pain, better aesthetic outcomes, and shorter recovery[13–15]. However, uptake of TEP repair is low because of the long, steep learning curve-a result of the limited working space and unusual landmarks[1,4]. Compared to TEP repair, TAPP repair affords a clearer clear field of view inside the pelvic cavity, similar to other laparoscopic surgeries. However, TAPP repair is associated with higher rates of port-site hernia and visceral injury, while TEP repair is more likely to require conversion[16]. Additionally, TAPP repair is more likely to result in adhesions, leading to intestinal obstruction[17].

To identify factors responsible for the difficulty of TEP repair, we focused on the relationship between obesity factors including BMI/subcutaneous fat/visceral fat and TEP repair. As shown in **Figure 3**, preoperative subcutaneous fat mostly correlated with operative time com-

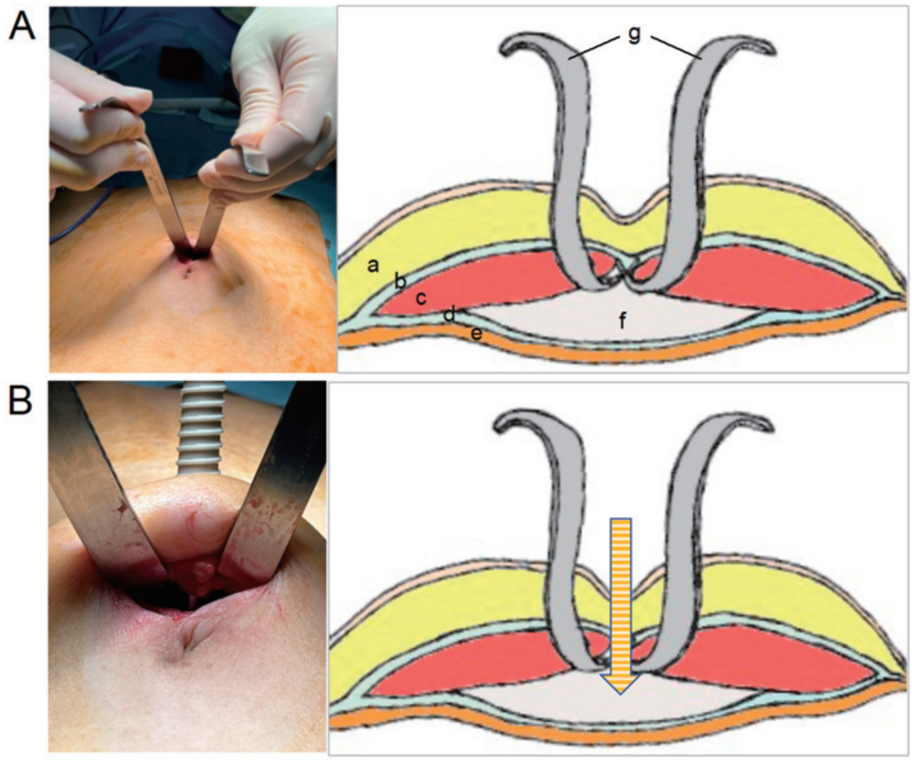

Fig. 4 Insertion of the first port using S-shaped retractors. (**A**) The camera port was temporarily removed and S-shaped retractors were inserted from the camera port wound. We retracted the subcutaneous fat, anterior rectus sheath, and rectus abdominis to secure space in the preperitoneal space. (**a**: subcutaneous fat, **b**: anterior rectus sheath, **c**: rectus abdominis, **d**: posterior rectus sheath, **e**: peritoneum, **f**: preperitoneal space, **g**: S-shaped retractors). (**B**) After securing space inside the preperitoneal space, the first port (yellow striped arrow) was inserted into the preperitoneal space.

pared to BMI and visceral fat. Based on this fact, we focused on preoperative subcutaneous fat as an indicator of the difficulty of TEP repair instead of BMI or visceral fat. Several studies have reported a correlation between operative time and BMI in TEP repair and robotic inguinal hernia repair[7,18]. However, no study examined the correlation of subcutaneous fat with endoscopic hernia repair. The present study showed that HSFI was associated with significant higher values for operative time and peritoneal injury rate. The higher peritoneal injury rate for HSFI patients was likely due to difficulty in recognizing preperitoneal anatomy because of the presence of abundant fat tissue and poor visibility. This suggests that the preperitoneal space is an unfamiliar anatomical perspective and that the risk of peritoneal injury is thus high. Because TEP repair involves forming a space between the fusion membrane, like searching inside darkness, an anatomical landmark is important for dissection oriented to the preperitoneal space.

To further identify factors responsible for the difficulty of TEP repair, we divided the TEP procedure into five phases and two sub-phases. Operative time was significantly longer during dissection of the caudal side of the preperitoneal space, particularly during insertion of the first port. Nishimura et al. reported that the time required for insertion of the first port in laparoscopic gynecologic surgeries was significantly longer in patients with high subcutaneous/preperitoneal fat, as measured by preoperative ultrasonography[19]. We believe that operative time, particularly during insertion of the first port, was significantly longer for HSFI patients because of the thick abdominal wall, as the unclear views increase insertion time. In patients abundant in preoperative subcutaneous fat, the camera port was temporarily removed and the subcutaneous fat, anterior rectus sheath, and rectus abdominis was retracted from the camera port wound using S-shaped retractors (Takasagoika, Tokyo, Japan; **Fig. 4A**). Then, the first port was inserted certainly under direct vision to prevent peritoneal injury (**Fig. 4B**).

Our results suggest that preSFA is a factor in the difficulty of TEP repair-a finding that has considerable potential for helping trainees to learn surgical skills and optimize surgical procedures. Selecting patients with low subcutaneous fat may help shorten the learning period for trainees. TEP repair requires highly specialized skills and a complete understanding of preperitoneal anatomy, and further analyses of the procedure will help clarify the training necessary.

The limitations of this study include its retrospective design, the small number of cases, and lack of long-term follow-up, which was limited to patients who developed complications within 30 days of the procedure.

In conclusion, preSFA measurement was an effective method for identifying factors responsible for the difficulty of TEP repair. Restriction of TEP repair to patients with low subcutaneous fat may be helpful for trainees hoping to overcome the long, steep learning curve.

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Conflict of Interest: None declared.

References

1. Simons MP, Aufenacker T, Bay-Nielsen M, et al. European Hernia Society guidelines on the treatment of inguinal hernia in adult patients. Hernia [Internet]. 2009 Aug;13(4): 343–403. Available from: https://www.ncbi.nlm.nih.gov/pubmed/19636493
2. Shiroshita H, Inomata M, Akira S, et al. Current Status of Endoscopic Surgery in Japan: The 15th National Survey of Endoscopic Surgery by the Japan Society for Endoscopic Surgery. Asian J Endosc Surg [Internet]. 2021 Dec 26;. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34954907
3. Choi YY, Kim Z, Hur KY. Learning curve for laparoscopic totally extraperitoneal repair of inguinal hernia. Can J Surg [Internet]. 2012 Feb;55(1):33–6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/22269299
4. Lau H, Patil NG, Yuen WK, Lee F. Learning curve for unilateral endoscopic totally extraperitoneal (TEP) inguinal hernioplasty. Surg Endosc [Internet]. 2002 Dec;16(12): 1724–8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/12098025
5. Cecchini S, Cavazzini E, Marchesi F, Sarli L, Roncoroni L. Computed tomography volumetric fat parameters versus body mass index for predicting short-term outcomes of colon surgery. World J Surg [Internet]. 2011 Feb;35(2):415–23. Available from: https://www.ncbi.nlm.nih.gov/pubmed/21153815
6. Makino H, Kunisaki C, Izumisawa Y, et al. Effect of obesity on laparoscopy-assisted distal gastrectomy compared with open distal gastrectomy for gastric cancer. J Surg Oncol [Internet]. 2010 Aug 1;102(2):141–7. Available from: https://www.ncbi.nlm.nih.gov/pubmed/20648584
7. Kato JM, Iuamoto LR, Suguita FY, Essu FF, Meyer A, Andraus W. Impact of obesity and surgical skills in laparoscopic totally extraperitoneal hernioplasty. Arq Bras Cir Dig [Internet]. 2017 Jul-Sep;30(3):169–72. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29019555
8. Nyhus LM. Individualization of hernia repair: a new era. Surgery [Internet]. 1993 Jul;114(1):1–2. Available from: https://www.ncbi.nlm.nih.gov/pubmed/8356511
9. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg [Internet]. 2004 Aug;240(2):205–13. Available from: https://www.ncbi.nlm.nih.gov/pubmed/15273542
10. Irving BA, Weltman JY, Brock DW, Davis CK, Gaesser GA, Weltman A. NIH ImageJ and Slice-O-Matic computed tomography imaging software to quantify soft tissue. Obesity (Silver Spring) [Internet]. 2007 Feb;15(2):370–6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/17299110
11. Kvist H, Chowdhury B, Grangard U, Tylen U, Sjostrom L. Total and visceral adipose-tissue volumes derived from measurements with computed tomography in adult men and women: predictive equations. Am J Clin Nutr [Internet]. 1988 Dec;48(6):1351–61. Available from: https://www.ncbi.nlm.nih.gov/pubmed/3202084
12. Gomez-Perez SL, Haus JM, Sheean P, et al. Measuring abdominal circumference and skeletal muscle from a single cross-sectional computed tomography image: A step-by-step guide for clinicians using National Institutes of Health ImageJ. JPEN J Parenter Enteral Nutr [Internet]. 2016 Mar;40(3):308–18. Available from: https://www.ncbi.nlm.nih.gov/pubmed/26392166
13. Chung RS, Rowland DY. Meta-analyses of randomized controlled trials of laparoscopic vs conventional inguinal hernia repairs. Surg Endosc [Internet]. 1999 Jul;13(7):689–94. Available from: https://www.ncbi.nlm.nih.gov/pubmed/10384076
14. Heikkinen TJ, Haukipuro K, Hulkko A. A cost and outcome comparison between laparoscopic and Lichtenstein hernia operations in a day-case unit. A randomized prospective study. Surg Endosc [Internet]. 1998 Oct;12(10): 1199–203. Available from: https://www.ncbi.nlm.nih.gov/pubmed/9745056
15. Liem MS, van der Graaf Y, van Steensel CJ, et al. Comparison of conventional anterior surgery and laparoscopic surgery for inguinal-hernia repair. N Engl J Med [Internet]. 1997 May 29;336(22):1541–7. Available from: https://www.ncbi.nlm.nih.gov/pubmed/9164809
16. Schmedt CG, Sauerland S, Bittner R. Comparison of endoscopic procedures vs Lichtenstein and other open mesh techniques for inguinal hernia repair: a meta-analysis of randomized controlled trials. Surg Endosc [Internet]. 2005 Feb;19(2):188–99. Available from: https://www.ncbi.nlm.nih.gov/pubmed/15578250
17. McCormack K, Wake BL, Fraser C, Vale L, Perez J, Grant A. Transabdominal pre-peritoneal (TAPP) versus totally extraperitoneal (TEP) laparoscopic techniques for inguinal hernia repair: a systematic review. Hernia [Internet]. 2005 May;9(2):109–14. Available from: https://www.ncbi.nlm.nih.gov/pubmed/15703862
18. Kudsi OY, Bou-Ayash N, Gokcal F. Comparison of perioperative outcomes between non-obese and obese patients undergoing robotic inguinal hernia repair: a pro-

pensity score matching analysis. Hernia [Internet]. 2021 May 31;. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34057626

19. Nishimura K, Yoshimura K, Hoshino K, Myoga M, Hachisuga T. Aiming for complete safety of first trocar insertion of laparoscopic surgery: usefulness of preoperative ultrasonography of umbilical region. J Obstet Gynaecol Res [Internet]. 2019 Mar;45(3):652–6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30575236

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