



Review article

Small trocar site hernia after laparoscopy

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ABSTRACT

This review article is attempted to review the cases of 5-mm trocar site hernias (TSHs) after laparoscopic surgery and identify the risks associated with incarceration. We searched the English literature on the PubMed website using the key words "trocar site hernia" and "5 mm". We evaluated a total of 24 cases of 5-mm TSHs and analyzed and results showed that 17 (71%) and 7 (29%) resulted from gynecologic and gastrointestinal surgeries, respectively. The majority were found at the lateral abdomen (87.5%) and recognized within 2 weeks (87.5%). The most frequently herniated organ ($n = 14$) was the small bowel. Up to 62.5% of cases ($n = 15$) were repaired by exploratory laparotomy, and 25% ($n = 6$) required resection of herniated organs secondary to incarceration. The cases with incarceration were detected at 4.3 ± 2.2 days post-operation and those without incarceration at 47.4 days post-operation. No risk factors could be identified to show a correlation between 5-mm TSHs and incarceration. We concluded that immediate 1–2-week postoperative care is of most importance, since the majority of 5-mm trocar site hernias with or without incarceration occurred within this period.

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Introduction

Laparoscopic procedures have been developed very successfully in recent decades.¹ The advantages and disadvantages (limitations) have nearly all been previously reported.² Trocar site hernia (TSH) is one of the well-known postoperative complications.^{3,4} Although TSHs can occur in wounds of any size, ranging from 2 mm to 15 mm, most reported cases are in wounds larger than 10 mm.⁴ However, a TSH can occur in a relatively small wound, for example, a 5-mm wound. Because 5-mm TSHs are extremely rare^{3–58} and sometimes contribute to a catastrophic condition (for example, incarceration) this danger may be underestimated. Therefore, this review focussed

on 5-mm TSHs, and the purpose of this review was to improve our understanding of 5-mm TSHs and minimize their subsequent risk.

Materials and methods

For this review, a nonsystematic PubMed search of published data was performed with the following search terms: "trocar site hernia" and "5 mm". Only articles published in English from 1991 to March 2012 were searched.

Statistical analysis was performed using Fisher exact test, the χ^2 test, or Student *t* test. A value of $p \leq 0.05$ was considered statistically significant.

Results

After a careful search of the PubMed website using the key words "trocar site hernia", and "5 mm", we found 113 articles

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addressing this topic. One case from our own experience was also added. We read 56 articles and found 24 cases of hernias at 5-mm trocar sites to complete this review (Table 1), and the remaining 57 articles were excluded, for reasons such as an absence of full articles obtained, or no mention of 5-mm TSHs in the article. Seventeen 5-mm TSHs (71%) cases occurred after gynecologic laparoscopic surgeries and the remaining seven (29%) cases occurred after gastrointestinal surgeries (Table 2). All cases were left open at the fascial layers. In all, 12.5% of 5-mm TSHs were located at the midline, and 87.5% of cases occurred at the lateral abdomen. In this review, we did not further separate 5-mm TSHs at the lateral abdomen into the left or the right lateral abdomen, because the anatomical structure of the bilateral abdominal wall is similar, and of most importance, the surgical field included the upper and lower abdomen; therefore, the operator might stand either on the left or on the right side of the patient when the patient was in the supine position. In addition, 5-mm TSHs at the midline incision included the umbilicus and extraumbilicus sites. Twenty of the 24 5-mm TSHs (82.5%) occurred within 2 weeks after laparoscopic surgery. The small bowel was the most frequently herniated organ ($n = 14$), followed by the omentum ($n = 8$). The protrusion of the small intestine or omentum presented symptoms resulting from the entrapment of the bowel or omentum. All of the 5-mm TSHs with a herniated small bowel occurred within 2 weeks after laparoscopic surgery and more than 90% of cases presented as a small bowel obstruction. Exploratory laparotomy was often used to repair the 5-mm TSHs ($n = 15$, 62.5%). Six 5-mm TSH cases were complicated with incarceration, which required resection of the herniated organs, including three at the small bowel, two at the omentum, and one at the fallopian tube (Table 3). In comparing incarceration and nonincarceration, no risk factors could be identified, although the occurrence of incarceration seemed to be earlier than that of nonincarceration (4.3 days vs. 47.4 days).

Discussion

TSH is a rare but well-known phenomenon with a prevalence of 0.5% (range, 0–5.2%).⁴ Early-onset TSH developed in the early stages after surgery, presenting symptoms within 2 weeks after laparoscopic surgery.⁵ A higher incidence of early-onset TSHs was found at 5-mm trocar sites (83%, $n = 20$), suggesting the importance of early identification. Toub and Campion⁶ reported a 5-mm TSH secondary to omentum herniation, with fluid leakage from the incision wound as the main symptom. Wang et al³ reported an incarcerated fallopian tube with postoperative vague pain. The reported predisposing factors for TSHs include umbilical location,^{4,18} preexisting fascial defect,^{18,19} compressed air effect,^{20–22} preschool age,^{3,23–25} age >60 years,²⁶ obesity, and long surgical time,²⁷ or some comorbidities associated with a fascial defect, for example, adjuvant chemotherapy for cervical cancer⁶ and breast cancer with abdominal metastasis.¹¹

Huang et al¹¹ reported a case presenting a 5-mm TSH on postoperative Day 1, but the defect was measured as three times the initial length on the computed tomography examination. All patients underwent reduction of TSHs either by laparotomy ($n = 15$) or laparoscopy ($n = 9$), and six patients needed resection of a partial small bowel, omentum, or fallopian tube (Table 2). After reduction or resection of the herniated organs, an aponeurotic closure at the hernia site was performed for all patients.

To further improve our understanding of 5-mm TSHs, three major topics (risk factors associated with surgical techniques, risk factors associated with patients, and closure techniques) are discussed.

Risk factors associated with surgical techniques

One main limitation should be noted first in the discussion of risk factors associated with surgical techniques. Because the occurrence of 5-mm TSHs is extremely low, the discussion might not be limited to 5-mm TSHs. By contrast, many data of risk factors for TSHs might be derived from all-sized TSHs, and most of them were based on 10-mm TSHs. Therefore, this discussion cannot be fully representative of the discussion of 5-mm TSHs.

Location

Nezhat et al⁷ reported that the occurrence of TSHs at 5-mm trocar sites was unusual, because the incidence was less than 0.1%. Duron et al²⁸ suggested the lateral wall is composed of two fascial planes and muscle, and that the likelihood of dehiscence is decreased, a finding supported by animal studies (muscle reapposition after blunt trocars).^{29,30} However, the arcuate line may demarcate an inherent weakness of the abdominal fascia.³¹ In a clinical survey, the umbilical area was still the most common site of TSHs (75.7%), although most TSHs (86.3%, 725 of 840 hernias) might occur in TSHs 10-mm or larger.³² However, Tonouchi et al⁵ found 13 TSHs in the lateral region compared with 17 TSHs in the midline region, suggesting the underestimated risk of TSHs in the lateral region. These conflicting data seem to be confusing. The possible reasons include: (1) the use of a large trocar in the midline leading to a much greater risk of herniation, especially at the umbilicus site^{32,33}; and (2) the low expected overall incidence because of the unknown true incidence secondary to high percentages of asymptomatic TSHs, which may be missed or unreported.⁸ However, based on this review and the data in Table 2, we believe that the incidence of TSHs in the lateral region might be higher than we suspect.

Prolonged surgery, extensive manipulation, and stretching the incision for retrieval

Uslu et al²⁷ reported that the mean surgical time for laparoscopic cholecystectomy was at least twofold longer in the TSH group than in the non-TSH group (94.5 minutes vs. 50.5 minutes, respectively), suggesting that the longer the surgery, the greater the risk of tissue disruption at the trocar sites and the longer the tissue healing time. Nezhat et al⁷ supported the concept that extensive manipulation of the 5-mm trocar sites resulted in TSHs, because these 5-mm TSHs were associated with advanced surgical complications, including severe endometriosis, large uterine leiomyoma, and extensive adhesions. Based on our review (Table 1), we concluded that extensive manipulation or frequent dislodgement might widen the fascial defect. In fact, one report showed that the fascial defect was three times the initial length (15.5 mm compared with the 5-mm trocar site).¹¹ Thapar et al³⁴ reported an original 5-mm trocar site might be widened after removal of the 20-French (6.7-mm) catheter. Nassar et al¹⁷ mentioned the extension of the umbilical fascial defect as the most significant risk factor, because the stretching involved in retrieval might increase the risk of TSHs. Forced dilation of the fascial layer due to prolonged surgery and extensive manipulation has been proposed as an etiological mechanism.³⁶ However, in this review, we did not know whether the occurrence of TSHs is really more common on the lateral incisions, which are closer to the operator's side, or on the opposite side. If TSHs occur more frequently on the operator's side, it is likely that routine fascial closure might be required if stretching of the incision wound cannot be avoided during surgery.³⁷

Table 1
Literature review of 5-mm port wound hernias.

Source	Procedure	Location, no.	Day ^a	Symptom	Organ	Reduction method	Discussion
Plaus ⁸	Laparoscopy for pelvic pain, cholecystectomy	Midline suprapubic, 2 ^b	7/120	SBO /pain	Omentum/omentum	Laparotomy	Paramedian sites preferred over midline ones
Toub and Campion ⁶	Radical hysterectomy	Left lower quadrant, 1	4	Fluid leakage	Incarceration of omentum	Laparotomy	Adjuvant chemotherapy on postoperative d 3
Matter et al ¹²	Cholecystectomy	Right upper quadrant, 1	10	Pain	Small bowel	Laparotomy	Reinsertion of cannula widens defect
Waldhausen ²³	Toupet fundoplication	Left lower quadrant, 1	5	NDA	Small bowel	NDA	22-mo-old child
Nezhat et al ⁷	Hysterectomy, adhesiolysis, 5 cases	Left abdomen, 5	2/2/6/ 12/229	SBO/SBO/N/V / N/V/ pain	Small bowel or omentum	Laparoscopy, one had small bowel resection	Extensive manipulation due to complicated surgeries
Eltabbakh ¹³	Staging surgery for endometrial cancer	Extraumbilical, 1	7	SBO	Small bowel	Laparotomy	Prolonged operative laparoscopy
Reardon et al ⁹	Fundoplication	Left abdomen, 1	2	SBO	Incarceration of small bowel	Laparotomy with end-to-end anastomosis	Extensive manipulation in long procedure
Nakajima et al ²⁴	Nissen fundoplication	Right lower quadrant, 1	6	SBO	Small bowel	Laparoscopy	6-mo-old infant
Kwok ¹⁴	Pelvic floor repair and colposuspension	Left abdomen, 1	180	A mass	Omentum	Laparotomy	3 cm in diameter at previous 5-mm trocar site
Wang et al ³	Laparoscopic cystectomy	Left abdomen, 1	7	Pain with a mass	Fallopian tube	Laparotomy, excision of Fallopian tube	9-y-old child (immaturity)
Bergmann et al ¹⁹	Uncomplicated tubal ligation	Umbilical (3 mm), 1	2	A mass	Omentum	Laparotomy	1.5 cm preexisting fascial defect
Bourdel et al ¹⁵	Laparoscopic hysterectomy	Left abdomen, 1 1	8	SBO	Small bowel	Laparoscopy	3 successive extractions and introductions for needle passage
Moreaux et al ¹⁰	Staging surgery for endometrial cancer, 2 patients	Right abdomen, 2	6/6	SBO	Small bowel/ incarceration of small bowel	Laparoscopy/ laparotomy (end-to-end anastomosis)	Herniations after removal of drains
Huang et al ¹¹	Laparoscopic BSO and PALNS	Left abdomen, 1	1	SBO	Incarceration of small bowel	Laparotomy, (end-to-end anastomosis)	15.93 mm defect on CT scan; breast cancer
Thapar ³⁴	Laparoscopic cystectomy	Right lower quadrant, 1	2	SBO	Small bowel	Laparoscopy	Herniation after removal of 20 French drain
Yamamoto ³¹	Laparoscopic hysterectomy	Left abdominal 1	4	SBO	Small bowel	Laparotomy	Extensive manipulations
Dulskas ²⁶	Laparoscopic cholecystectomy	Right abdomen, 1	365	Bulging mass	Large bowel and omentum	Laparotomy	Advanced age (63 y old) and obesity (BMI: 36)
This study	Laparoscopically assisted vaginal hysterectomy	Left abdominal 1	3	SBO	Small bowel	Laparotomy	Increased intra-abdominal pressure during reversal of anesthesia

BMI = body mass index; CT = computed tomography; NDA = No data available; N/V = nausea or vomiting; SBO = small bowel obstruction; BSO = bilateral salpingo-oophorectomy; PALNS = para-aortic lymph node sampling.

^a Interval refers to the time between laparoscopy and diagnosis of herniation.

^b One patient presented with both 12-mm and 5-mm trocar site hernias.

Table 2
Summary of the characteristics of the 24 cases of 5-mm trocar site hernia.

Type of procedure	Gastrointestinal surgery: 7 Gynecologic surgery: 17
Location	Midline (including umbilical): 3 Lateral: 21
Symptom	Small bowel obstruction: 13 Pain: 4 Nausea/vomiting: 2 Mass: 4
Organ	Fluid secretion: 1 Small bowel: 14 Omentum: 8 Large bowel: 1 Fallopian tube: 1
Reduction of hernia	Laparotomy: 15 Laparoscopy: 9
Resection of herniated organ	Yes: 6 No: 18
Association with surgical technique	Yes ^a : 15 No ^b : 9

^a Midline incision, manipulation/prolonged surgery, drain insertion, increasing intra-abdominal pressure during reversal of anesthesia.
^b Young/old age, obesity, previous facial defect, chemotherapy, comorbidity.

Trocar types and entry techniques

As shown in animal studies,^{29,30} muscle and fascia reposition after blunt trocar insertion can occur in the lateral abdominal wall.^{29,30} In one prospective study ($n = 110$)³⁸ and three retrospective studies ($n = 747$, $n = 92$, and $n = 350$, respectively),^{39–41} there was no TSH at 5-mm, 10-mm, or 12-mm paramedian blunt trocar sites during a follow-up of 4.8–36 months. Leibl et al⁴² reported that the cutting trocar was associated with a significantly higher TSH rate than blunt trocars ($n = 600$; 1.8% vs. 0.2%, $p < 0.01$). However, a Cochrane review in 2008⁴³ did not show a difference between blunt and cutting trocar sites, and there was no advantage in using one single technique over another to prevent major complications; however, this review did not address the topic of TSHs. Wallace and O'Dwyer⁴⁴ evaluated 568 open laparoscopies and found that no postoperative TSHs had occurred during a 1-week follow-up period. A prospective nonrandomized study ($n = 403$) comparing entry techniques using either a Veress needle (closed laparoscopy) or the Hasson technique (open laparoscopy) showed six TSHs (3%) in the Verness group but no TSH in the open entry group during a follow-up period of 3–51 months ($p = 0.01$).³⁵ One of the six TSHs resulted from nonclosure of the fascia; all fascial defects due to open laparoscopy were closed with absorbable sutures. However, the wound infection rate might be higher in a closed laparoscopy, which caused an increase in the incidence of TSHs.³⁵

Table 3
Comparison of incarceration and nonincarceration.

	Incarceration ($n = 6$)	Nonincarceration ($n = 18$)	<i>p</i>
Mean duration (d)	4.3 ± 2.2	47.4 ± 99.5	0.092
Organs			0.290
	Small bowel	11 (61.1)	
	Omentum	6 (33.3)	
	Large bowel	8 (5.6)	
	Fallopian tube	0 (0)	
Procedure	Gastrointestinal surgery	6 (85.7)	0.629
	Gynecologic surgery	12 (70.6)	
Symptoms	Small bowel obstruction	10 (55.6)	0.718
	Pain	3 (16.7)	
	Nausea/vomiting	1 (5.6)	
	Mass	2 (11.1)	
	Fluid	1 (5.6)	
Associated with surgical techniques ^a	Yes	11 (73.3)	1.00
	No	7 (77.8)	

Data are presented as n (%) unless otherwise indicated.

^a Yes: midline incision, manipulation/prolonged surgery, drain insertion, increasing intra-abdominal pressure during reversal of anesthesia; no: young/old age, obesity, previous facial defect, chemotherapy.

Closing fascial defects

There is no doubt that it is sometimes difficult to close the fascial level completely at 5-mm trocar sites. This is why some physicians leave 5-mm trocar sites open without closure, and use adhesive bands superficially as alternatives. Although there was no study that made a direct comparison of closure and nonclosure at 5-mm trocar sites to evaluate the risk of 5-mm TSHs, we still believe that closure of the 5-mm trocar site can avoid TSHs—based on our findings in Table 1, all 5-mm TSHs occurred when the fascial defects were not closed. This concept was supported by a retrospective study,⁴⁵ which found that 10-mm or larger TSHs were substantially more common if the fascia defect was left open, although closure did not completely avoid the occurrence of TSHs. Furthermore, Helgstrand et al⁴⁶ reviewed 95 cases of TSHs at trocar sites 10-mm or larger in 12,304 patients in general surgery and urologic oncology, and found that the incidence of TSHs after closure and nonclosure of the fascia was 0.6% (42 of 8719) and 1.5% (53 of 3585), respectively. The TSHs in the fascia-closure group might be secondary to the surgical technique or surgical materials (for example, suture materials). The incidence of TSHs seemed to be higher in the fast-absorbable suture (Vicryl or Polysorb) group than in the slow-absorbable suture group (PDS, synthetic monofilament absorbable polydioxanone, Ethicon, Johnson & Johnson, Cincinnati, Ohio) [1.7% (18 of 1067)^{39,47} vs. 0.2% (15 of 6089)^{48–50}]. Therefore, it is recommended that trocar sites 10-mm or larger be closed with slow absorbable sutures.

Effects of compressed air

Increased intra-abdominal pressure might push bowel loops or the omentum through the trocar incisions, and the protruding organs might be trapped by abdominal muscle.^{20–22} A partial vacuum effect created by withdrawal of the trocar or drain catheter might draw organs into the fascial defect.^{10,28,34} In our experience, a cough during reversal of anesthesia could increase intra-abdominal pressure, which might increase the risk of TSH. It is recommended that trocars be removed under direct visualization or with a blunt instrument to avoid the partial vacuum effect.¹⁰

Risk factors secondary to the patients

Obesity

Obesity might be a factor contributing to the increased risk of TSHs because of the difficulty of definite closure of the fascial defect and the tendency to increased abdominal pressure in these

patients.⁵¹ In a prospective study of bariatric surgery, the incidence of 10-mm TSHs after closure of the fascia was 1.3% (9 of 747) during a 4–43 month follow-up period; some TSHs were recognized within 5–9 months after surgery.³⁹ Dulskas et al²⁶ reported a late-onset TSH that occurred within 1 year after laparoscopic cholecystectomy at a lateral 5-mm trocar site; the patient's body mass index (BMI) was 36. Uslu et al²⁷ suggested a BMI higher than 25 might be a risk factor for TSH during the 1-month follow-up period after laparoscopic cholecystectomy. As the above-mentioned studies show, TSH in obese patients was often of a late-onset type; therefore, long-term follow-up is highly recommended after laparoscopic surgery in obese patients.

Children

Three patients with TSH at lateral 5-mm trocar sites were children (age 6 months, 22 months, and 9 years, respectively; Table 1).^{3,23,24} Prematurity of the subcutaneous fatty and muscular layer in children might be a risk factor. Paya et al²⁵ suggested children younger than 5 years have a significantly high risk of TSHs, and recommended meticulous suturing of all layers, particularly the peritoneum, and even in small incisions (2 mm), to prevent omental protrusion at trocar sites in children younger than 5 years.

Advanced age

Dulskas et al²⁶ reported that a large bowel and omental herniation were found in a 63-year-old patient with late-onset TSH at a lateral 5-mm trocar site 1 year after laparoscopic cholecystectomy. Uslu et al²⁷ reported that patients with trocar site hernias had an average age of 60 years, and that the average age of those without this complication was 50 years.

Preexisting fascial defects

Bergemann et al¹⁹ reported a 32-year-old woman with omental herniation at a 3-mm trocar site due to a preexisting 1.5-cm fascial defect after tubal ligation surgery. The incidence of preexisting umbilical fascial defects was up to 18% in 2100 patients undergoing laparoscopy.⁵² In a report of 1300 cases of laparoscopic cholecystectomy, nine of 10 TSHs developed in patients in whom preexisting fascial defects were diagnosed preoperatively.⁵³ Although these case reports were limited to the defects of the umbilicus, it is rational to suppose that this risk might contribute to the trocar sites other than the umbilicus.

Comorbidity

Fascial defects, potentially secondary to malignancy, might be widened during laparoscopy.^{6,11} Diabetes mellitus is related to an increased incidence of wound infection in laparotomic surgery, but the relationship between diabetes mellitus and the incidence of TSHs was not statistically significant.^{5,46} Some authors suggested that postoperative wound infection might be a predisposing factor of TSH.^{35,54}

Closure techniques

There is no doubt that it is sometimes difficult to fix the fascial level completely at 5-mm trocar sites. Although the occurrence of 5-mm TSH might be low and it may be relatively harmless, minimization of the 5-mm TSH is needed. Primary repair of incisions with specially designed instruments (including special needles such as the J needle (Medtronic Limited, Vero Beach, FL), Veress needle

(Medtronic Limited, Vero Beach, FL), reusable Reverdin needle (Surgicon Pvt. Ltd., Sialkot, Pakistan), Carter-Thomason Needle-point Suture Passer (Louisville Apl Diagnostics, Seabrook, TX), hypodermic needle (Becton, Dickinson and Company, Franklin Lakes, NJ), Grice needle (Lemaitre Vascular, Inc., Burlington, MA), and 15 gauge spinal cord needle (Medtronic Limited, Vero Beach, FL)) and some specially designed trocars that were invented to minimize the need of fascia closure, can reduce the likelihood of TSHs.^{39,47,55,56}

In conclusion, because the incidence of 5-mm TSHs is extremely low, and all 5-mm TSHs occurred at wound sites without closure, we suggest that the 5-mm trocar site can be closed with a delayed absorptive suture. In addition, dangerous incarceration is often identified immediately or shortly after laparoscopic surgery (average, 4 days), so patients should be informed about this complication so that early detection can minimize the risk of incarceration of the bowel.

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