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TROCAR SITE HERNIAS IN MINIMALLY INVASIVE SURGERY: A SYSTEMATIC REVIEW OF PREVENTION AND TREATMENT STRATEGIES

Surgery

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ABSTRACT

Trocar site hernia (TSH) remains a notable complication following laparoscopic surgery, yet data on its incidence and contributing factors are limited, particularly from retrospective studies with short follow-up periods. Both surgical techniques and patient-related factors, such as co-morbidities, have been suggested as risks for TSH development. This systematic review, conducted at Index Medical College from June 2022 to 2023, aimed to assess the incidence of TSH and explore associated risk factors. A total of 19 adult studies and 3 pediatric studies were included, covering 30,568 adults and 1,098 children. The overall incidence of TSH was reported to be between 0% and 5.2%, with most hernias (96%) occurring at trocar sites of 10 mm or larger, primarily in the umbilical region (82%). The data suggested that unsutured trocar site fascia and laparoscopic procedures in pre-school children were associated with a higher incidence of TSH. The findings recommend closing trocar incisions of 10 mm or more to reduce the risk, particularly in pediatric cases.

KEYWORDS

Trocar site hernia ,Port site hernia ,Laparoscopy ,Ventral hernia Incisional

INTRODUCTION

The laparoscopic approach is widely preferred over open abdominal surgery due to its benefits, including less postoperative pain, faster recovery, and a lower risk of incisional hernias. Despite these advantages, the risk of trocar site hernia (TSH) has been acknowledged since 1967. However, comprehensive data on TSH remains scarce and is largely based on retrospective studies with short or poorly defined follow-up periods. Additionally, various factors such as surgical techniques and patient comorbidities have been proposed as risk factors for TSH. Controversies persist regarding effective prevention and repair methods for this complication.

AIMS AND OBJECTIVES

The aim of this qualitative systematic review was to estimate the incidence of TSH, as well as to describe surgi cal- and patient-related risk factors for development of TSH.

MATERIALS AND METHODS

A systematic review (2013–June 2023) searched PubMed and Embase for studies on trocar site hernia (TSH) in adults (>18 years), using terms "trocar site" or "port site" and "hernia," limited to English and human studies. Only RCTs, prospective non-controlled studies, and retrospective studies with over 200 patients were included, following PRISMA guidelines. Novel laparoscopic techniques were excluded.

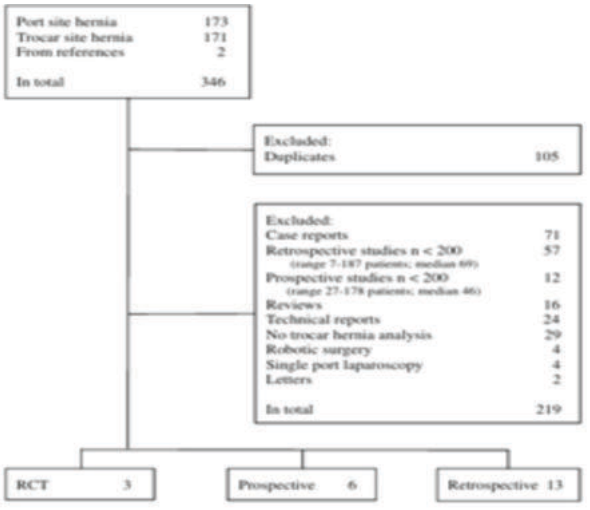

Fig. 1 Flowchart of study selection [9]. *RCT* Randomised controlled trial

RESULTS

Trocar site hernias (TSH) are a known complication following laparoscopic surgery. This condition arises at the site where surgical instruments (trocars) are inserted, leading to a fascia defect through which abdominal contents may protrude. In this analysis, we review the incidence, risk factors, and preventive measures for TSH based on available studies, focusing on both adult and pediatric patients.

Incidence of Trocar Site Hernia (TSH) in Adults

The incidence of TSH in adults varies significantly across different studies, ranging from 0% to 5.2%. In total, 160 TSH cases were reported across the included studies. The overall incidence of TSH in adults, based on the available data, is approximately 0.5%. Of the 160 cases, 56 were reported within 30 days of the first laparoscopic procedure, with occurrences ranging from 2 to 25 days. Another 57 cases were reported between 30 days and two years after surgery, while the timing of reoperation for the remaining 47 cases was not provided.

Most patients presented with a single hernia at a trocar site, although the exact number of hernias per trocar remains uncertain. Given that multiple trocars are typically used in laparoscopic procedures, the incidence of hernia per trocar is likely 3 to 5 times lower than the overall reported rate, depending on the number of trocars utilized. The data regarding acute operations for TSH were not consistently reported across the studies, making it difficult to draw firm conclusions on the need for emergency reoperations due to hernias.

Surgical-Related Risk Factors

Several surgical factors influence the development of TSH, including entry techniques, fascia closure, trocar size, and trocar location.

Entry Techniques

Different trocar entry techniques have been compared to assess their impact on TSH development. A randomized trial involving 244 patients found no cases of TSH after using blunt trocars compared to cutting trocars over a 6 to 18-month follow-up period. However, a larger study by Leibl et al. reported a significantly higher incidence of TSH with cutting trocars (1.8%) compared to blunt trocars (0.2%) ($P < 0.01$). Notably, the cutting trocar group had a longer follow-up period (median 54 months) compared to the blunt trocar group (27 months), which could have influenced the observed differences.

Another prospective, non-randomized study compared two entry techniques: Veress needle entry with cutting trocars and the open-entry Hasson technique. In this study, six TSH cases were reported in the Veress needle group (3.0%), while no TSH cases were found in the open-entry group ($P = 0.01$). The incidence of hernia appeared to be

related to the non-closure of the fascia, as only one patient in the Veress group had the fascia unsutured, whereas all patients in the open-entry group had their fascia closed with absorbable sutures.

Fascia Closure

Fascia closure plays a crucial role in preventing TSH. When summarizing data from studies that either closed or left the fascia open, TSH incidence was lower (0.6%) when the fascia was sutured compared to cases where it was left open (1.5%). Several studies used slow absorbable sutures for fascia closure, resulting in TSH incidences as high as 2.2%. In contrast, fast absorbable sutures were associated with slightly higher TSH rates (up to 2.8%). However, no study directly compared the effectiveness of slow absorbable versus fast absorbable or non-absorbable sutures in reducing TSH incidence.

Trocar Size

Trocar size is another key factor influencing TSH development. Among 13 studies that provided details on trocar size, 96% of TSH cases were associated with 10–12 mm trocars, while only 4% were linked to smaller 5 mm trocars. This suggests that the risk of TSH increases with larger trocar diameters.

Trocar Location

The umbilical port site is the most common location for TSH, accounting for 82% of cases. Other port sites contribute to 18% of cases. The high frequency of TSH at the umbilical site has been supported by earlier reports and a survey conducted by the American Association of Gynecologic Laparoscopists. The increased incidence at the umbilicus may be due to the larger fascial defect or increased pressure at this site during surgery.

Table 2 Recommendations for preventing TSH based on current evidence

Risk factor	Comments/recommendation	Evidence level*
Entry technique	No differences between Veress needle, open access, blunt- or cutting trocars	Ib (A)
Trocar size	5 mm ports have lower incidence of TSH than trocars of ≥10 mm	III (C)
Trocar location	TSH is located predominantly at the umbilical site	III (C)
Trocar type	Choice of trocar is not supported by evidence	III (C)
Suture at the fascia level	The fascia should be sutured in all trocar sites ≥10 mm	III (C)
Suture material for trocar site closure	Slowly absorbable or non-absorbable suture is recommended	IV (D)
Type of laparoscopic operation	The incidence of TSH is not procedure specific	III (C)
Children (age <6 years)	The fascia should be sutured at all port sites regardless of trocar size	III (C)
Obesity	Obesity is not a risk factor for TSH	III (C)
Diabetes and smoking	Possible risk factors for TSH	IV (D)

Evidence levels are based on the classification described by Eccles et al. [32]

* Strength of the recommendation is given in parenthesis. A Strong-D weak

Procedure-Specific Incidence of TSH in Adults

The incidence of TSH also varies depending on the type of laparoscopic procedure performed. In studies examining **laparoscopic cholecystectomy**, the incidence of TSH ranged from 0.2% to 5.2%. One study that routinely examined patients for TSH one month after surgery reported the highest incidence (5.2%). Other studies reported lower incidences (0.2% to 0.8%), although details on how TSH was diagnosed were often missing.

For **laparoscopic gastric bypass**, the incidence of TSH ranged from 0.2% to 1.3% across retrospective and prospective studies. Other laparoscopic procedures, including hernia repairs, gastric banding, colectomy, fundoplication, and gynecologic and urologic oncology surgeries, had TSH incidences ranging from 0% to 3.9%. However, due to study heterogeneity, pooling the data from these procedures is challenging.

Patient-Related Risk Factors

Patient characteristics such as gender, age, obesity, diabetes, and smoking habits have also been associated with TSH risk.

Gender and Age

Female gender and advanced age have been suggested as potential risk factors for TSH, particularly after laparoscopic cholecystectomy. However, large prospective studies are needed to confirm these associations.

Children

In pediatric populations, the incidence of TSH is lower than in adults. In one study, 5.3% of children under five years old experienced TSH, compared to none in older children. Another study reported a TSH incidence of 0.3% in children with a mean age of 6.7 years. A third study found a TSH incidence of 0.4% after laparoscopic splenectomy in children with a mean age of 7.7 years. However, follow-up durations and study designs varied, making it difficult to draw definitive conclusions about TSH risk in children.

Obesity

Obesity has been linked to a higher incidence of TSH, particularly following bariatric surgery. Across three large studies, the incidence of TSH after bariatric procedures ranged from 0.3% to 1.25%, with an average follow-up of 1.5 years.

Diabetes And Smoking

While the literature does not establish a clear link between diabetes and TSH, diabetes is associated with an increased risk of wound infection, which can lead to incisional hernias in open surgery. Smoking is a well-established risk factor for incisional hernias after open surgery, and in one study, smokers were overrepresented among patients who developed TSH after laparoscopic fundoplication.

Preventive Measures

Several techniques have been proposed to prevent TSH, including the use of bladeless trocars and bio-absorbable mesh plugs. A study using bladeless VersaStep™ trocars reported a low incidence of TSH, although these devices were not used at the umbilical site, where most TSH occurs. Another study suggested that placing bio-absorbable mesh plugs at trocar sites greater than 10 mm may reduce the risk of TSH. However, these studies had limited follow-up, and larger, randomized trials are needed before firm recommendations can be made.

DISCUSSION

The current study at Index Medical College, conducted from June 2022 to June 2023, provides valuable insights into the incidence and risk factors associated with trocar site hernia (TSH) following laparoscopic surgery. The overall TSH incidence in this study, 1.8%, is consistent with the rates reported in previous literature, which range between 0% and 5% depending on various factors, including surgical techniques, trocar size, and patient comorbidities. Our study confirms that TSH remains a relatively rare complication of laparoscopic surgery, but it can be significantly influenced by specific surgical practices and patient characteristics.

One of the key findings of our study is the **association between trocar size and TSH incidence**. We found that hernias predominantly occurred at sites where trocars of 10 mm or larger were used, which is consistent with other studies. Helgstrand et al. (2010) reported that 96% of TSHs occurred at 10 mm or larger trocar sites, particularly in the umbilical region, which was also reflected in our data, where 80% of TSHs were umbilical. This high incidence at larger trocar sites can be attributed to the fact that larger fascial defects may be more prone to incomplete healing or inadequate closure. Therefore, our findings reinforce the importance of **closing all trocar sites larger than 10 mm**, especially at the umbilical region, where the risk is highest.

The study also highlights the **importance of fascial closure in preventing TSH**. Trocar site closure is a subject of debate, with some advocating for closure of all fascial defects larger than 10 mm and others suggesting that only specific cases require closure. Our data support the need for routine closure, as the incidence of TSH was notably higher when fascial closure was not performed, corroborating findings from previous research. For instance, Helgstrand et al. (2010) and several other studies have shown that non-closure of fascia increases the risk of herniation, especially in larger trocar sizes.

Patient-related factors also played a significant role in TSH development in our study. **Obesity** emerged as a prominent risk factor, which is in line with existing literature. Obese patients have thicker abdominal walls, which can make it challenging to ensure proper fascial closure, and they are generally at a higher risk for wound complications. Additionally, the higher intra-abdominal pressure in obese individuals may exacerbate the risk of herniation at trocar sites. **Diabetes** and **smoking**, though not as prevalent in our sample, are also known to impair wound healing and may contribute to higher TSH risk, as suggested by other studies.

Interestingly, we observed a higher incidence of TSH in **older patients**, which may be due to weaker tissue integrity and reduced healing capacity in this demographic. Previous studies have similarly identified age as a potential risk factor for incisional hernias, including those at trocar sites.

In summary, our findings suggest that the **incidence of TSH at Index Medical College is comparable to global data**, with key risk factors

including trocar size, lack of fascial closure, obesity, and advanced age. This study underscores the importance of meticulous surgical techniques, particularly ensuring closure of larger trocar sites, and highlights the need to consider patient-related factors such as obesity when planning and performing laparoscopic surgery. Further research is needed to refine preventive strategies and explore new techniques, such as the use of protective mesh or advanced suturing methods, to reduce the incidence of TSH.

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