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ORIGINAL ARTICLE

Influencing factors for port-site hernias after single-incision laparoscopy

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Abstract
Purpose Single-incision laparoscopic surgery (SILS) has been demonstrated to be a feasible alternative to multiport laparoscopy, but concerns over port-site incisional hernias have not been well addressed. A retrospective study was performed to determine the rate of port-site hernias as well as influencing risk factors for developing this complication.
Methods A review of all consecutive patients who underwent SILS over 4 years was conducted using electronic medical records in a multi-specialty integrated healthcare system. Statistical evaluation included descriptive analysis of demographics in addition to bivariate and multivariate analyses of potential risk factors, which were age, gender, BMI, procedure, existing insertion-site hernia, wound infection, tobacco use, steroid use, and diabetes.
Results 787 patients who underwent SILS without conversion to open were reviewed. There were 454 cholecystectomies, 189 appendectomies, 72 colectomies, 21 fundoplications, 15 transabdominal inguinal herniorrhaphies, and 36 other surgeries. Cases included 532 (67.6 %) women, and among all patients mean age was 44.65 (±19.05) years and mean BMI of 28.04 (±6). Of these, 50 (6.35 %) patients were documented as developing port-site incisional hernias by a health care provider or by incidental imaging. Of the risk factors analyzed, insertion-site hernia, age, and BMI were significant. Multivariate analysis indicated that both preexisting hernia and BMI were significant risk factors (p value = 0.00212; p value = 0.0307). Morbidly obese patients had the highest incidence of incisional hernias at 18.18 % (p value = 0.02).
Conclusions When selecting patients for SILS, surgeons should consider the presence of an umbilical hernia, increased age and obesity as risk factors for developing a port-site hernia.

Keywords Single-incision laparoscopy · Port-site hernias · Risk factors · Incisional hernia

Introduction

With the adoption of laparoscopic surgery over the past few decades, investigators have attempted to categorize and risk stratify the complication of trocar site hernia. Reports in the literature regarding rates of these hernias are conflicting, and many risk factors have been suggested. Early studies had established umbilical hernia rates as low as 1.5 % for laparoscopic cholecystectomy when using the Hasson technique [1]. A more recent prospective study by Comajuncosas et al. [2], however, reports a rate of 25.9 % when following patients regularly for 3 years with physical exam and ultrasound. Elevated BMI, pre-existing umbilical hernia, wound infection, age, and gender have all been proposed as risk factors for developing such a complication with the traditional laparoscopic approach [3–5]. Questions remain regarding optimal closure technique in the setting of multiple patient risk factors, and these concerns have been complicated by the use of larger laparoscopic incisions for insertion of multi-trocar ports.

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In recent years, single-incision laparoscopic surgery (SILS) has been demonstrated to be a safe alternative to multiport laparoscopy for many laparoscopic procedures, but despite its cosmetic appeal, concerns remain due to loss of triangulation, increased costs, and lack of randomized trials proving objective benefit to patients [6–9]. Furthermore, studies analyzing long-term complications such as port-site incisional hernia have been few. Agaba et al. [10] recently reported single-incision port-site hernia incidence of 2.9 % in 205 patients that were followed prospectively 30–36 months after cholecystectomy; 50 % of these complications were in morbidly obese patients. In contrast, Marks et al. [11] published a much higher incisional hernia rate of 8.4 % in a 1 year randomized controlled trial comparing SILS and traditional multiport cholecystectomy, suggesting that significantly higher hernia rates may outweigh the potential cosmetic benefit. Studies intended to analyze specific risk factors for incisional hernia after SILS have not been published. Such analysis may help direct physicians in choosing ideal patients for the single-incision approach to minimize future complications. A retrospective review of patients who underwent any SILS procedure at our facility was conducted to determine the rate of port-site incisional hernias as well as influencing risk factors for developing this complication.

Materials and methods

Patient selection

All single-incision laparoscopic surgeries performed at a single institution by three surgeons in our integrated multispecialty healthcare system between November 2008 and December 2012 were reviewed via a comprehensive electronic medical record system. This time period included the initial experience with SILS and the development period of a consistent closure technique. The decision to perform SILS was made according to surgeon preference as the time period includes the initial learning curve for the technique; no surgeon had experience with SILS prior to the study. Patient demographics recorded included age, gender, and BMI. Additional information gathered included existing insertion site hernia, current tobacco use, daily steroid use, and diabetes status. Intra-operatively, conversions from SILS to multiport, hand-assisted laparoscopy, and laparotomy were documented. For the purpose of analyzing risk factors for incisional hernia after SILS surgery, surgeries in which the port-site was extended for hand-assist or open conversion were not included. Totally extraperitoneal herniorrhaphies were also excluded. Recurrence, incarceration, and strangulation were documented for incisional hernias that were discovered.

Surgical method

For a typical SILS case in our institution, access is gained to the peritoneal cavity with a 2 cm incision within the umbilicus and extending to the fascia. A three-trocar SILS^{TM} (Covidien, Mansfield, MA) port is inserted through the fascial defect using a Kelly clamp. Instrumentation includes a 5 mm bariatric 30° angled scope with right angle adapter and standard 5 mm non-articulating instruments. After completion of the laparoscopic procedure, the SILS port is removed and the fascial defect is closed using 0 polyglycolic acid suture in two figure-of-eights. The soft tissues are loosely approximated using 3–0 polyglycolic acid suture. In lieu of closing the skin with a 4–0 monofilament suture, a suction dressing is created by applying a small amount of triple antibiotic ointment, gauze, and a clear adhesive bandage, after which air is suctioned out using a 60 cc syringe and 27 gauge needle [12]. For colectomies, often the incision was extended to 3 cm to allow for extraction of the specimen, necessitating a different closure technique; in these cases the fascia was closed using a number 1 looped absorbable monofilament suture in a running fashion.

Statistical analysis

All variables are described using means (standard deviations) or percentages, as appropriate. Statistical evaluation included descriptive analysis of demographics in addition to bivariate analysis of potential risk factors, which included age, gender, BMI, procedure, existing insertion-site hernia, wound infection, tobacco use, steroid use, and diabetes. Bivariate analysis consists of either *t*-tests or Chi-squared/Fisher's exact tests, as appropriate, comparing those with and without complication. Performing a multivariate analysis allowed for statistical analysis of each outcome variable while accounting for more than one covariate at a time. In this portion of the analysis, logistic regression models were built for incisional hernia complication, including as covariates surgical procedure and any potential risk factor reaching a significance level of 0.2 on the bivariate analyses above. Finally, to discern which category of obesity was at highest risk, we performed an additional analysis, comparing hernia rates in patients with BMI less than 25, greater than 25–30, greater than 30–35, greater than 35–40, and greater than 40, using Chi-squared tests.

Results

Upon review, 787 SILS cases met inclusion criteria for this study. There were 454 cholecystectomies, 189 appendectomies, 72 colectomies, 21 fundoplications, 15

Table 1 Analyses of potential risk factors for port-site hernias

Risk factor	Bivariate p value	Multivariate p value
Age	0.00223	0.055
Gender	0.71	N/A*
BMI	0.01	0.031
Surgical procedure	0.12	See Table 2
Insertion-site hernia	0.00012	0.002
Wound infection	0.27	N/A*
Tobacco use	0.21	N/A*
Steroid use	0.83	N/A*
Diabetes	0.08	0.561

* Did not reach significance level of 0.2 on bivariate analysis

Table 2 Incisional hernia rate by BMI range

BMI range	Incisional hernia rate (%)
<25	3.50
≥25 < 30	6.90
≥30 < 35	9.40
≥35 < 40	5.77
≥40	18.18

transabdominal inguinal herniorrhaphies, and 36 procedures classified as other. Cases included 532 (67.6 %) women, and overall patients had a mean age of 44.65 (19.05) (range 5–91) years and a mean BMI of 28.04 (6) (range 13.3–49.5). Of these patients, 50 (6.35 %) patients were documented as developing a port-site incisional hernia by physical exam or by incidental imaging, for which they chose to follow up with a provider. Bivariate analysis revealed that of the potential risk factors investigated, only pre-existing insertion site hernia, age, and BMI were significant (Table 1). Patients with pre-existing trocar site hernias had an incisional hernia rate of 12.64 %. Patients with a BMI greater than or equal to 40 had the highest rate of incisional hernia at 18.18 % (Table 2, p value = 0.02). Of note, surgical procedure type was not a statistically significant factor for incisional hernia (Tables 1, 3). Additionally, the overall wound infection rate was 2.03 % and was not found to be a statistically significant influencing factor for developing a hernia in this analysis (Table 1).

Multivariate analysis using covariates age, BMI, insertion site hernia, and diabetes indicated that both a preexisting hernia and BMI were significant independent risk factors (Table 1). Of the incisional hernias that developed, 18 patients (36 %) had a prior umbilical incision, and 9 (18 %) were classified as recurrent incisional hernias. There were no incarcerated or strangulated hernias. Of the 50 hernias detected, 30 required non-emergent surgical intervention due to symptomatic presentation. Average time to presentation in our facility was 9.41 months. Average follow up was 34 months and ranged from 12 to 62 months.

Discussion

The goal of this review was to provide direction to surgeons considering the single-incision technique by denoting potential risk factors for incisional hernia. Our experience indicates a rate of clinically significant incisional hernias of 6.35 %. This rate is higher for the morbidly obese, elderly, and patients with pre-existing hernias. The overall number falls within the broad range reported for incisional hernias when using the Hasson trocar, which varies from 1.5 to 25 %, but is considerably higher than that reported in the study by Agaba et al. [10] for SILS cholecystectomy. This disparity may be due to difference in closure technique, larger database, longer maximum follow up, or a wider variety of cases, though surgical procedure itself was not a significant influencing factor in this analysis. Descriptions of closure for single-incision port sites in the literature are varied, including interrupted, two or three figure-of-eights, and running fashions, as well as both absorbable and non-absorbable suture [10, 13, 14]. Communication between high-volume SILS centers and standardization of closure technique may be valuable in reducing these rates.

Supporters of SILS cite its cosmetic appeal, patient satisfaction, and potentially reduced post-operative pain with decreased number of incisions [6, 7, 11, 15, 16]. Other advantages such as shorter length of stay for colectomy and decreased risk of trocar morbidity for inguinal

Table 3 Incisional hernia rate and statistical significance by procedure type

Surgical procedure	Rate of incisional hernia	Multivariate p value
Cholecystectomy	35/454 (7.71 %)	0.426
Appendectomy	6/189 (3.17 %)	0.561
Hemicolectomy	3/72 (4.17 %)	0.603
Fundoplication	2/21 (9.52 %)	0.483
Inguinal hernia repair	0/15 (0 %)	0.988
Other	4/36 (11.11 %)	0.260

herniorrhaphy have also been suggested [17–20]. Skeptics argue a potentially substantial learning curve and unnecessary expenses with the use of specialized ports and articulating instruments [8, 9, 21]. We have argued that increased experience and standardization of training and technique may be useful in overcoming these difficulties, and with most procedures, we find that standard laparoscopic instruments can be utilized [21, 22]. Robotic single-incision has been introduced as a potential way to overcome triangulation and clashing difficulties, but hospital expense and lengthy operative times remain serious concerns [23–25].

Aside from cholecystectomy, few randomized trials are available regarding SILS and most lack long term follow up specific to incisional hernia rates. This review represents one of the largest databases of single-incision surgery within a single institution and offers a unique opportunity to learn from our collective experience. The use of a bariatric camera with 90° angled adapter, for example, minimizes crowding at the port. Closure of the umbilical skin with only deep dermal interrupted stitches and a homemade suction dressing has also decreased post-operative pain at the umbilicus.

In our study we found the highest incisional hernia rates in patients who were morbidly obese and in those with pre-existing umbilical hernias. Agaba et al. also demonstrated higher incidence in this population, with 83 % of patients who developed incisional hernias classified as obese and 50 % of these patients meeting criteria for morbid obesity [10]. Our practice now avoids performing SILS in the obese due to increased operative difficulty and high incisional hernia rates, which could be explained by increased visceral fat and subsequent increase in intra-abdominal pressure at the umbilicus. In addition, surgeons may wish to consider alternative closing techniques, such as three figure-of-eights utilized by Agaba et al. who had a comparatively lower incisional hernia rate overall. Closure of umbilical hernias encountered during laparoscopic cholecystectomy with interrupted non-absorbable suture has been suggested in the literature [5]. The use of mesh in clean-contaminated cases has also been identified as a potential method of decreasing port-site hernias in high risk patients who may not have a pre-existing hernia [26].

Limitations of this study include its retrospective design as well as inherent bias in surgeon selection of approach. Universal electronic medical records across a multi-specialty healthcare system facilitated reporting of complication even several years after surgery, but some complications may have been missed due to loss to follow up in our system. Additionally, routine imaging was not performed in diagnosing hernias. Thus, the reported rate may be lower than the actual rate, but we believe those documented to be clinically relevant as they involved utilization of healthcare resources, follow up or surgery after discovery. A prospectively designed study comparing SILS and multiport approaches may provide more accurate hernia rates but could be difficult to maintain without significant resources.

SILS is safe and feasible, but large reviews and randomized controlled trials regarding long term complications are limited. This large retrospective review holds important clinical implications for surgeons and their patients, who may be able to balance a desire for improved cosmetic result with patient-specific risk of long-term complication.

Compliance with ethical standards

Conflict of interest F.P. Buckley, MD has received a speaker honorarium in the past from Medronic. No other authors have any conflicts.

Ethical approval All procedures performed were in accordance with the ethical standards of the institution, received IRB approval, and with the 1964 Helsinki declaration and its later amendments.

Informed consent As a retrospective study, formal consent was not obtained from the patients and was not required.

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