Original Article

Does the morphology of the umbilicus influence the incidence of surgical site infections in transumbilical single-incision laparoscopic appendectomy?

Dae Jun Lee, Kwang Yong Kim, Soo Kyung Ahn, Sang Nam Yoon, Ji Woong Cho, Sam Yeol Lee, Bong Hwa Jung, Byung Chun Kim, Ji Woong Hwang

Department of Surgery, Kangnam Sacred Heart Hospital, Hallym University College of Medicine, Seoul, Republic of Korea

Abstract

Background: Transumbilical laparoscopic appendectomy (TULA) may be a feasible alternative to conventional laparoscopic appendectomy. However, a transumbilical incision may increase incisional surgical site infections (SSIs) compared to conventional laparoscopic appendectomy. This study aimed to investigate the relationship between the morphology of the umbilicus and the incidence of SSIs in patients who underwent TULA.

Patients and Methods: This retrospective study analysed the medical records of consecutive patients who underwent surgery for acute appendicitis at our institution from June 2016 to October 2020. The patients were assigned to the SSI group (those with an SSI) or the non-SSI group. The morphology of the umbilicus was calculated by measuring its width and depth on preoperative computed tomography images and was compared between the SSI and non-SSI groups.

Results: The SSI group included 23 patients, while the non-SSI group included 252 patients. The width of the umbilicus was significantly shorter in the SSI group than in the non-SSI group (29 ± 10 mm vs. 34 ± 9 mm, $P = 0.027$). The umbilicus was slightly deeper in the SSI group than in the non-SSI group; however, the difference was not significant (16 mm vs. 15 mm, $P = 0.384$).

Conclusions: This was the first study investigating the correlation between the morphology of the umbilicus and SSI development in TULA. SSIs tended to occur more commonly in a narrow and deep umbilicus. An extension of the umbilical incision may help prevent SSI in patients with this umbilical morphology.

Keywords: Appendicitis, surgical site infection, transumbilical laparoscopic appendectomy, umbilicus

Address for correspondence: Prof. Ji Woong Hwang, 1 Singil-ro Yeongdeungpo-gu, Seoul 07441, Republic of Korea.
E-mail: dattoree@gmail.com

Submitted: 10-May-2021, **Accepted in Revised Form:** 30-Jul-2021, **Published:** 13-Oct-2021

INTRODUCTION

Laparoscopic appendectomy is accepted as the current standard operative technique for treating acute appendicitis, even for complicated appendicitis. The benefits of laparoscopic surgery include wider views of the abdominal cavity, decreased hospital stays, reduced postoperative pain and improved cosmetic outcomes.[1] Over the years, the conventional laparoscopic appendectomy technique has remained unchanged and has been conducted with a

Access this article online	
Quick Response Code:	Website: www.journalofmas.com
	DOI: 10.4103/jmas.jmas_157_21

How to cite this article: Lee DJ, Kim KY, Ahn SK, Yoon SN, Cho JW, Lee SY, *et al*. Does the morphology of the umbilicus influence the incidence of surgical site infections in transumbilical single-incision laparoscopic appendectomy? J Min Access Surg 2022;18:505-9.

three-port (5- or 10-mm umbilical, 5-mm anti-McBurney and 5-mm suprapubic) technique.

Increasing experience in minimally invasive surgery enables minimisation of invasiveness by reducing the number of abdominal trocars. Since the publication of the first report describing transumbilical single-incision laparoscopic surgery for hysterectomy in 1992,[2] the use of transumbilical surgery has gradually increased in various surgical fields. After laparoscopic appendectomy through a single umbilical incision was introduced in 1992,[3] many studies have investigated the feasibility of single-incision laparoscopic appendectomy and have shown that single-incision laparoscopic appendectomy may be a safe and feasible alternative to conventional laparoscopic appendectomy.[4-7]

However, the transumbilical incision may increase the incidence of incisional surgical site infections (SSIs) as the umbilicus is reportedly abundant in bacteria.[8-11] To the best of our knowledge, the relationship between the morphology of the umbilicus and the incidence of SSIs has not been investigated. Therefore, this study aimed to investigate the relationship between the morphology of the umbilicus and the incidence of SSIs in patients who underwent laparoscopic appendectomy.

PATIENTS AND METHODS

This retrospective study was approved by the institutional review board (IRB No. HKS 2021-02-027) of our institution. The requirement for informed consent was waived due to the retrospective nature of the study. The study conforms to the guidelines set out in the Declaration of Helsinki. The medical records of consecutive patients who underwent surgery for acute appendicitis in our institution from June 2016 to October 2020 were retrospectively reviewed [Figure 1]. The exclusion criteria were: patients who underwent multiport laparoscopic or open appendectomy, conversion from transumbilical to multiport laparoscopic appendectomy, patients diagnosed with acute appendicitis by abdominal ultrasonography, and were <19 years old. After exclusion, the patients enrolled in this study were assigned to either the SSI or non-SSI group based on whether they developed incisional SSIs. The demographic information, morphology of the umbilicus and operative outcomes were compared.

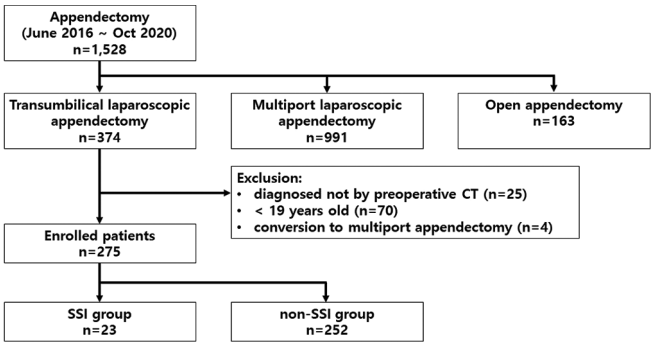

Figure 1: A flowchart showing enrolment of patients who have undergone transumbilical laparoscopic appendectomy. CT: Computed tomography, SSI: Surgical site infection

Patient demographic data (age, sex, past medical history [hypertension, diabetes mellitus (DM), cardiovascular disease], American Society of Anaesthesiologists (ASA) score, weight, body mass index (BMI), and pre-operative white blood cell count), operative outcomes (severity of appendicitis, operative time, presence of abdominal drainage, length of postoperative stay, incisional SSI, other complications (organ/space SSI and ileus) and readmission within 30 days after discharge) were investigated. The severity of appendicitis was categorised as hyperaemic, suppurative, gangrenous and perforated based on the findings in the intraoperative findings. The SSI was categorised as incisional SSI or organ/space SSI according to the guidelines of the Centres for Disease Control and Prevention.[12]

The morphology of the umbilicus was investigated by measuring its width and depth at the deepest end on the axial view of the pre-operative computed tomography image [Figure 2a]. The two parameters were examined by two co-authors independently, and the mean value of their measurements was used for further analysis. The ratio of width to depth (WTD) was defined as the depth divided by the width of the umbilicus and the degree of narrowing of the umbilicus. A smaller WTD indicated a narrower umbilicus, while a larger WTD indicated a wider umbilicus [Figure 2b].

Operative technique

Pre-operative intravenous antibiotics were injected within 1 h before skin incision. A combination of second-generation cephalosporins and metronidazole was most commonly used. The umbilicus was cleaned with

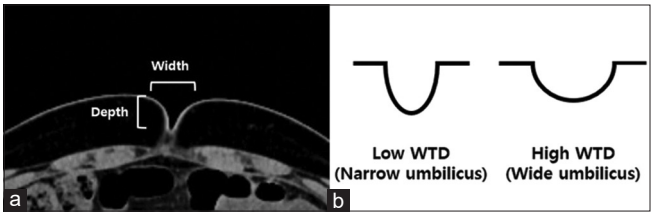

Figure 2: (a) The measurements of the width and the depth of the umbilicus using preoperative computed tomography images. (b) The schema of the two types of umbilicus. WTD: The width to depth ratio

a cotton swab soaked in a 70% alcohol solution. After preparing skin with a 5% iodine solution, a longitudinal 2–2.5 cm wide incision was made in the midline of the umbilicus from the superior edge to the inferior edge of the umbilicus. The peritoneal cavity was accessed using the usual Hassan open technique. A glove port was inserted into the transumbilical incision site. The appendectomy procedure was the same as that for conventional multiport laparoscopic appendectomy. The same instruments used in multiport laparoscopic appendectomy were used in this study. No special equipment, such as reticulating instruments, was required. The only difference was that the resected appendix was removed through the glove port without an endo-bag. The fascia was closed with 2-0 Vicryl sutures, and the buried intradermal suture was placed using 4-0 Vicryl sutures for skin closure. Compression dressing with dry gauze was generally applied to the umbilicus to prevent seroma formation in the subcutaneous fat tissue.

Statistical analysis

Continuous variables were compared using a Student's *t*-test, and categorical variables were analysed using a Chi-square test. Statistical significance was set at $P < 0.05$. All statistical analyses were conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corporation, Armonk, NY, USA).

RESULTS

Of 1,528 patients identified, 374 had undergone transumbilical laparoscopic appendectomy (TULA). Of these, 99 patients were excluded, and 275 patients were enrolled in this study [Figure 1]. Among these patients, four were readmitted after discharge (3 patients with deep SSI; 1 with a post-operative ileus). An incisional hernia occurred in one patient. The SSI group included 23 patients, while the non-SSI group included 252 patients.

Table 1 shows the patient demographics of the SSI and non-SSI groups. Demographic variables, except BMI, were not significantly different between the two groups. The BMI in the SSI group was not significantly different compared to the non-SSI group (25.3 ± 5.6 kg/m^2 vs. 23.7 ± 3.5 kg/m^2, $P = 0.185$). Patients with hypertension were proportionately higher in the SSI group than in the non-SSI group; however, the difference was not significant (6 patients [21.6%] vs. 30 patients [11.9%], respectively, $P = 0.054$).

The severity of appendicitis was significantly associated with the occurrence of SSI [Table 2]. SSI was more common in patients with gangrenous appendicitis than in patients with perforated appendicitis. The operative time and length of post-operative stay were significantly

Table 1: Patients' demographics of the surgical site infections and nonsurgical site infections groups

Variables	SSI group (*n*=23)	Non-SSI group (*n*=252)	*P*
Age (years)	45.5±19.1	44.7±15.5	0.824
Sex (female), *n* (%)	10 (43.5)	137 (54.4)	0.316
Weight (kg)	69.5±17.5	64.8±13.6	0.122
BMI (kg/m^2)	25.3±5.6	23.7±3.5	0.185
Past medical history, *n* (%)	7 (30.4)	45 (17.9)	0.140
HTN	6 (26.1)	30 (11.9)	0.054
DM	3 (13.0)	12 (4.8)	0.094
Cardiovascular disease	1 (4.3)	16 (6.3)	0.703
ASA score, *n* (%)			
1	8 (34.8)	142 (56.3)	0.047
≥2	15 (65.2)	110 (43.7)	
Preoperative level of WBC (/μL)	11,421.7±4643.5	11,344.6±4251.6	0.934

SSI: Surgical site infection, BMI: Body mass index, HTN: Hypertension, DM: Diabetes mellitus, ASA: American Society of anaesthesiologists, WBC: White blood cell

Table 2: Patients' operative outcomes of between the surgical site infections and nonsurgical site infections groups

Variables	SSI group (*n*=23)	Non-SSI group (*n*=252)	*P*
Severity of appendicitis, *n* (%)			
Hyperemic	2 (8.7)	20 (7.9)	0.045
Suppurative	11 (47.8)	180 (71.4)	
Gangrenous	6 (26.1)	23 (9.1)	
Perforated	4 (17.4)	29 (11.5)	
Operative time (min)	51.7±42.2	36.2±14.9	<0.001
Abdominal drainage, *n* (%)	9 (39.1)	56 (22.2)	0.068
Length of post-operative stay (days)	4.7±5.1	2.9±1.3	<0.001
Readmission within 30 days		4	
Deep/organ SSI	0	3	
Post-operative ileus	0	1	

SSI: Surgical site infection

longer in the SSI group than in the non-SSI group (52 min vs. 36 min, $P < 0.001$; 4.7 days vs. 2.9 days, respectively, $P < 0.001$).

The width of the umbilicus was significantly shorter in the SSI group than in the non-SSI group (29 ± 10 mm vs. 34 ± 9 mm, $P = 0.027$). The umbilicus was slightly deeper in the SSI group than in the non-SSI group; however, the difference was not significant (16 mm vs. 15 mm, $P = 0.384$). The WTD ratio in the SSI group was smaller than that of the non-SSI group (2.0 ± 0.8 vs. 2.3 ± 0.6, $P = 0.063$).

In Figure 3, the scatter plot of the distribution of the values of the depth of the umbilicus and the WTD comprehensively shows the aforementioned results. This scatterplot revealed that patients in the SSI group had a reduced distribution of the WTD ratio for each umbilicus depth.

DISCUSSION

In this study, the morphology of the umbilicus influenced the incidence of SSIs in patients who underwent TULA. Patients with a deep umbilicus developed a greater number of SSIs than those with a shallow umbilicus, although the difference was not significant. The width of the umbilicus significantly influenced the development of an SSI. In addition, a small umbilicus showed a greater tendency for SSIs than a large umbilicus. Of note, regarding the umbilical morphology, the narrower and deeper the umbilicus, the higher the incidence of SSIs compared to those that were wider and shallow.

This study showed that a narrow umbilicus was more likely to be infected than a wide umbilicus. The reasons for these results are as follows. First, patients with a narrow umbilicus are more likely to have poor hygiene because of difficulty in cleansing the area. Second, in patients with a narrow and deep umbilicus, the excision of the fascia is generally longer than that of the skin. This may result in more extensive subcutaneous tissue damage, which can lead to SSI. Third, due to the concave morphology of the umbilicus, an inappropriate suture of the dermis, especially at the bottom of the umbilicus, is likely to be performed in patients with narrow and deep umbilicus. In these patients, a greater extension of the umbilical incision may help prevent SSI.

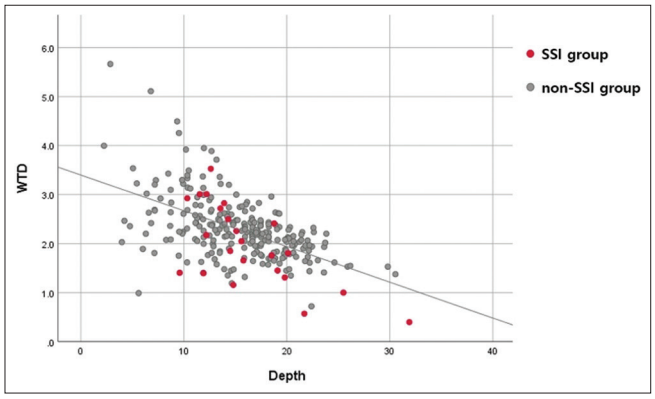

Figure 3: Scatter plot value of the width of the umbilicus and the width to depth ratio of the umbilicus of patients enrolled in this study. SSI: Surgical site infection, WTD: The width to depth ratio

As shown in Table 2, the severity of the appendix appeared to affect the occurrence of the SSI significantly. However, in patients with perforated appendicitis, the incidence of SSI was lower than that in patients with gangrenous appendicitis. This is thought to be because postoperative antibiotics were used in patients with perforated appendicitis.

The SSI group had a significantly longer operative time and post-operative stay than the non-SSI group. This may imply that there might have been more patients with complicated appendicitis in the SSI group. Many studies have suggested that TULA is technically more challenging for perforated appendicitis.[13-15] Complicated appendicitis makes dissection difficult due to severe intraperitoneal adhesion caused by inflammation. The authors tried to overcome this problem by making the umbilical incision a little longer to widen the working space for the intracorporeal instruments. Consequently, TULA could be performed safely without conversion to multiport laparoscopic or open appendectomy in most patients, and only four patients required additional ports.

In a randomised controlled trial, St Peter *et al*. have reported an SSI rate of 3.3% for TULA for uncomplicated appendicitis.[16] Other studies that included patients at all stages of appendicitis have reported SSI rates ranging from 4% to 11%.[11,17,18] The overall rate of SSI in our patients who underwent TULA for uncomplicated and complicated appendicitis (8.4%) is comparable to the results of these previous studies.

Medical history (hypertension, DM and cardiovascular diseases) or ASA score had no statistical difference in the occurrence of an SSI. Although body weight was not significantly different between the two groups, the BMI in the SSI group was significantly higher than that in the SSI group. Our results suggest that surgeons who perform TULA should pay more attention to patients with obesity to prevent SSIs.

The umbilicus has a 3-dimensional shape, unlike that of a conventional laparoscopic incision, and the concave shape of the umbilicus makes precise suturing difficult. A longer incision of the fascia beyond the umbilical margin to obtain a larger trocar site might result in a larger dead space, which leads to a seroma, and consequently, to SSI. To reduce the dead space, we usually compress the umbilical wound by filling the umbilical space with compacted dry gauze.

Our study has some limitations. First, this was a retrospective study with a small sample size. Prospective studies with large sample sizes are required to confirm our results. Second, we did not investigate whether SSIs were caused by resident bacteria in the umbilicus or by the intestinal microflora. Third, selection bias might have affected the results because the operation type depended on the surgeon's preference.

CONCLUSIONS

This study was the first to investigate the correlation between the morphology of the umbilicus and SSI development in those who underwent TULA. SSIs tended to occur more commonly in patients with a narrow and deep umbilicus. An extension of the umbilical incision may help prevent SSI in patients with this umbilical morphology. Further studies with larger sample sizes are required to confirm and expand on our findings.

Key points:

- The morphology of the umbilicus may influence the incidence of SSIs in patients who undergo TULA
- A small umbilicus showed a greater tendency for SSIs than a large umbilicus
- SSIs tended to occur more commonly in a narrow and deep umbilicus
- An extension of the umbilical incision may help prevent SSIs in patients with this umbilical morphology.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Eypasch E, Sauerland S, Lefering R, Neugebauer EA. Laparoscopic versus open appendectomy: Between evidence and common sense. Dig Surg 2002;19:518-22.
2. Pelosi MA, Pelosi MA 3rd. Laparoscopic supracervical hysterectomy using a single-umbilical puncture (mini-laparoscopy). J Reprod Med 1992;37:777-84.
3. Pelosi MA, Pelosi MA 3rd. Laparoscopic appendectomy using a single umbilical puncture (minilaparoscopy). J Reprod Med 1992;37:588-94.
4. Valla J, Ordorica-Flores RM, Steyaert H, Merrot T, Bartels A, Breaud J, *et al.* Umbilical one-puncture laparoscopic-assisted appendectomy in children. Surg Endosc 1999;13:83-5.
5. Pappalepore N, Tursini S, Marino N, Lisi G, Lelli Chiesa P. Transumbilical laparoscopic-assisted appendectomy (TULAA): A safe and useful alternative for uncomplicated appendicitis. Eur J Pediatr Surg 2002;12:383-6.
6. Zhang Z, Wang Y, Liu R, Zhao L, Liu H, Zhang J, *et al.* Systematic review and meta-analysis of single-incision versus conventional laparoscopic appendectomy in children. J Pediatr Surg 2015;50:1600-9.
7. Zhao L, Liao Z, Feng S, Wu P, Chen G. Single-incision versus conventional laparoscopic appendicectomy in children: A systematic review and meta-analysis. Pediatr Surg Int 2015;31:347-53.
8. Kleeff J, Erkan M, Jäger C, Menacher M, Gebhardt F, Hartel M. Umbilical microflora, antiseptic skin preparation, and surgical site infection in abdominal surgery. Surg Infect (Larchmt) 2015;16:450-4.
9. Hulcr J, Latimer AM, Henley JB, Rountree NR, Fierer N, Lucky A, *et al.* A jungle in there: bacteria in belly buttons are highly diverse, but predictable. PLoS One 2012;7:e47712.
10. Ohno Y, Morimura T, Hayashi S. Transumbilical laparoscopically assisted appendectomy in children: The results of a single-port, single-channel procedure. Surg Endosc 2012;26:523-7.
11. Muensterer OJ, Puga Nougues C, Adibe OO, Amin SR, Georgeson KE, Harmon CM. Appendectomy using single-incision pediatric endosurgery for acute and perforated appendicitis. Surg Endosc 2010;24:3201-4.
12. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Centers for disease control and prevention (CDC) hospital infection control practices advisory committee. Am J Infect Control 1999;27:97-132.
13. El-Beheiry M, Davidson J, Jones S, Bütter A, Scott L, Merritt N. Outcomes of extracorporeal, transumbilical versus intracorporeal laparoscopic appendectomy for acute uncomplicated appendicitis in children and adolescents: A retrospective observational cohort study. J Pediatr Surg 2019;54:1059-62.
14. Noviello C, Romano M, Martino A, Cobellis G. Transumbilical laparoscopic-assisted appendectomy in the treatment of acute uncomplicated appendicitis in children. Gastroenterol Res Pract 2015;2015:949162.
15. Go DY, Boo YJ, Lee JS, Jung CW. Transumbilical laparoscopic-assisted appendectomy is a useful surgical option for pediatric uncomplicated appendicitis: A comparison with conventional 3-port laparoscopic appendectomy. Ann Surg Treat Res 2016;91:80-4.
16. St Peter SD, Adibe OO, Juang D, Sharp SW, Garey CL, Laituri CA, *et al.* Single incision versus standard 3-port laparoscopic appendectomy: A prospective randomized trial. Ann Surg 2011;254:586-90.
17. Kulaylat AN, Podany AB, Hollenbeak CS, Santos MC, Rocourt DV. Transumbilical laparoscopic-assisted appendectomy is associated with lower costs compared to multiport laparoscopic appendectomy. J Pediatr Surg 2014;49:1508-12.
18. Bergholz R, Klein I, Wenke K, Boettcher M, Reinshagen K, Krebs T. Midterm outcome of transumbilically laparoscopic-assisted versus laparoscopic and open appendectomy in children--a matched prospective study. Eur J Pediatr Surg 2015;25:216-9.