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Evaluation of umbilical anatomy via computed tomography prior to single-incision laparoscopy

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Abstract

Laparoscopic surgery performed through a single incision is relatively new. Here, we investigated the importance of radiological anatomical evaluation of the umbilicus prior to such surgery.

Umbilical images of 500 patients who underwent computed tomography (CT) in 2019 were evaluated retrospectively, using both transverse and sagittal sections.

Spearman rank correlation analysis indicated a significant positive relationship between age and the sagittal and transverse umbilical measurements (all patients: $P < .01$; men: $P = .001$; women: $P < .01$). Mean transverse and sagittal measurements were 5.63 ± 1.9 and 6.2 ± 2.0 mm in women and 5.49 ± 1.9 and 6.2 ± 1.8 mm in men.

Umbilical anatomy can be evaluated radiologically as a component of preoperative evaluation.

Abbreviation: CT = computed tomography.

Keywords: computed tomography, laparoscopy, single-incision, surgery

1. Introduction

Over the past 30 years, laparoscopic approaches have been used to treat many benign and malignant diseases.[1–4] These laparoscopic approaches are preferred today because of their associations with lower complication rates than traditional open surgery, as well as less postoperative pain, better cosmetic results, and a more rapid return to normal daily life.[3,4] Many clinicians have sought to further reduce laparoscopic morbidity by using natural openings or single incisions. Minimally invasive surgery has been performed using only a single wide trocar placed in the navel.[5] The extent of postoperative pain remains unclear; such pain is affected by the incision method, length, and site. Umbilical anatomy is critical in this context.[5,6] The "umbilicus" has received minimal attention from anatomists; in atlases, the skin around the navel is often not dissected, and is presented as a simple button. The deep skin in the center of the navel has not been studied topographically. However, this situation is changing given the recent increase in single-port surgery.[7] Navel anatomy must be considered when seeking to minimize the abdominal wall destruction associated with single-port surgery; notably, the types of ports and surgical methods differ, with respect to changes in navel anatomy. Therefore, detailed anatomical knowledge of the umbilicus is essential.

2. Methods

We retrospectively analyzed 500 abdominal, 128-slice, CT datasets collected in the Tepecik Training and Research Hospital in 2019, using a detector made by Siemens Medical Solutions (Erlangen, Germany). For imaging, all patients lay supine. The tube voltage was 120 kV, the effective current was 150 mA, and the slice thickness was 1 mm. The exclusion criterion was planned abdominal surgery to treat an umbilical hernia in the absence of any pathology. Our local ethics board approved the study protocol. On axial images, we measured the transverse (longest) diameter in sections that contained the umbilical facial aperture (Fig. 1). Using reformatted sagittal images, we measured the craniocaudal diameter (i.e., longest diameter) in sections containing the facial opening (Fig. 2). All cases were evaluated by a radiologist, who later re-assessed them when blinded to the initial evaluations; this yielded a measurement of intra-observer reliability. All cases were re-evaluated by a second radiologist; this yielded a measurement of inter-observer reliability. Both radiologists were blinded to patient age. SPSS Statistics software (ver. 17; SPSS, Chicago, IL) was used for all statistical analyses. Data are expressed as means or medians with standard deviations, or as minima and maxima, as appropriate. Associations between age and sagittal umbilical measurements, as well as between age and transverse umbilical measurements, were sought via Spearman correlation analysis. Between-sex

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The datasets generated during and/or analyzed during the present study are publicly available.

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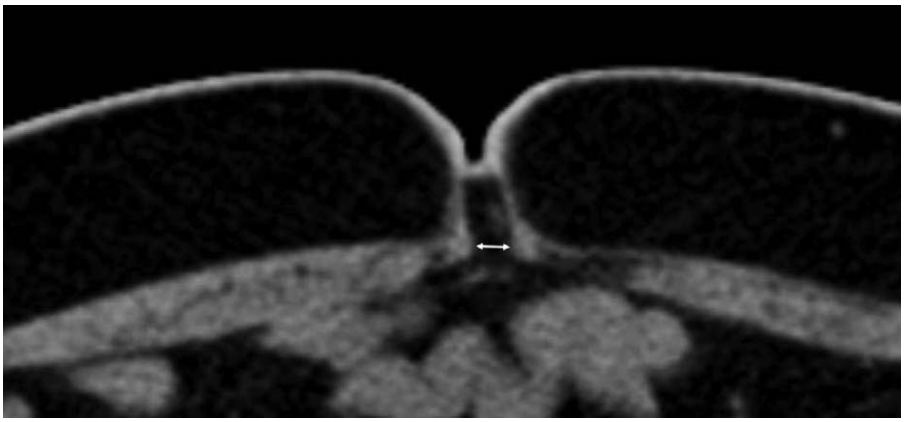

Figure 1. Measurements of transverse diamater on axial computed tomography image.

comparisons were performed using the Mann–Whitney *U* test. *P*-Values $< .05$ were considered to indicate statistical significance. The extents of intra-observer and inter-observer agreement were assessed using Cohen's κ test; we calculated κ values, weighted κ values, and agreement rates.

3. Results

We evaluated 500 abdominal CT datasets (250 women, 250 men; age range, 17–53 years; mean age of women, 32.29 ± 8.4 years; mean age of men, 32.30 ± 8.4 years). Transverse and sagittal measurements did not significantly differ on the basis of sex. Spearman rank correlation analysis indicated a significant (positive) relationship between age and both measurements (all subjects; $P < .01$; men: $P = .001$; women: $P < .01$). The means, standard deviations, medians, minima, and maxima of the transverse and sagittal section measurements are listed in Table 1. Mean transverse and sagittal measurements were 5.63 ± 1.9 and 6.2 ± 2.0 mm in women and 5.49 ± 1.9 and 6.2 ± 1.8 mm in men. We used κ statistics to evaluate the repeatability and reproducibility of our method. Cohen's κ test revealed very good intra-observer ($\kappa = 0.935$) and inter-observer ($\kappa = 0.912$) agreement.

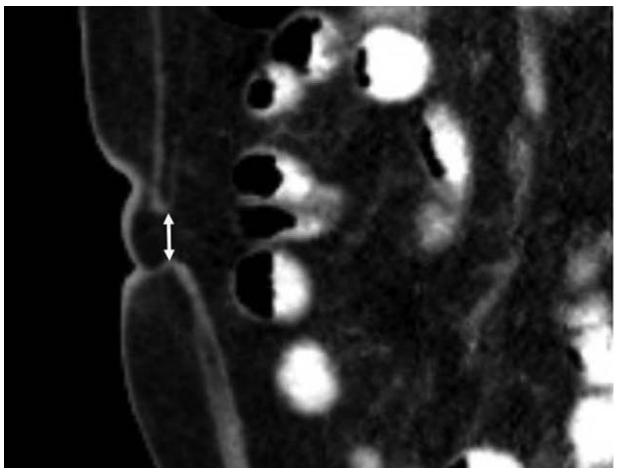

Figure 2. Measurements of sagittal diamater on reformatted sagital computed tomography image.

4. Discussion

In the past 30 years, minimally invasive surgeries (e.g., single-port surgery) have become popular. For cosmetic reasons, the umbilicus is often the site of first-trocar incision.[1–4] Traditionally, umbilical incision was generally avoided; surgeons who prefer traditional open surgery continue to avoid the umbilicus, which is presumed to release infective agents.[8–11] In 1987, Philippe Mouret performed the first laparoscopic cholecystectomy; this was a surgical revolution. Gradually, laparoscopic approaches began to be replaced by a single-incision approach, or other approaches through natural openings. In 2009, two-incision three-port laparoscopic cholecystectomy and natural orifice transluminal endoscopic surgery ushered in a new surgical era.[12,13] Minimally invasive surgery (such as surgery involving an umbilical incision) improves cosmetic results and reduces pain; thus, knowledge of umbilical anatomy is essential.

It remains unclear whether single-port surgery is superior to traditional laparoscopy. Pain reduction and cosmetic satisfaction are important. Although single-port surgery is presumed to reduce postoperative pain, some authors have reported conflicting findings.[14–18] The length of the incision and method by which it is created may be important, in addition to port selection; notably, port type and incision size are interrelated. Smaller incisions minimize postoperative pain. Several studies have shown that umbilical incision is associated with hernia of the higher trocar region. The incision must be carefully planned and meticulously created, guided by anatomical information.[18–21]

Single-port surgeries commence with skin incision of the inverted umbilicus. Preoperative, radiological anatomical evaluation is important if complete umbilical inversion might cause difficulties, especially in patients with obesity. Both umbilical size

Table 1

Minimum and maximum measurements, with means ± SDs and medians, at transverse and saggital section of umblicus.

Section	Sex	Number	Mean ± SD	Min–Max	Median
Transverse	Female	250	5,63 ± 1.95	3–11	5.10
	Male	250	5.49 ± 1.9	3.12	5.20
Sagittal	Female	250	6.2 ± 2.0	3.1–11.5	5.90
	Male	250	6.2 ± 1.8	3.3–10.2	6.00

Min–Max = minimum–maximum, SDs = standard deviations.

and the anatomical features are critical when selecting port sites. Detailed radiological examination has revealed anatomical variations that might be of clinical significance, as well as the presence of anatomical variants among different populations. There remains a need to study the effects of sex on surgical outcomes and postoperative complications.

5. Conclusion

We have shown that umbilical anatomy can be examined radiologically. This approach minimizes unnecessary tissue trauma during minimally invasive surgery, reveals appropriate port points, and allows evaluation of patient-specific anatomical features.

Author contributions

M.B.O and A.E. contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

References

[1] Langwieler TE, Nimmesgern T, Back M. Single-port access in laparoscopic cholecystectomy. Surg Endosc 2009;23:1138–41.
[2] Brodsky JA, Brody FJ, Walsh RM, et al. Laparoscopic splenectomy. Surg Endosc 2002;16:851–4.
[3] Maartense S, Bemelman WA, Gerritsen van der Hoop A, et al. Hand-assisted laparoscopic surgery (HALS): a report of 150 procedures. Surg Endosc 2004;18:397–401.
[4] Irwin BH, Rao PP, Stein RJ, et al. Laparoendoscopic single site surgery in urology. Urol Clin North Am 2009;36:223–35. ix.
[5] Asakuma M, Hayashi M, Komeda K, et al. Impact of single-port cholecystectomy on postoperative pain. Br J Surg 2011;98:991–5.
[6] Hayashi M, Asakuma M, Komeda K, et al. Effectiveness of a surgical glove port for single port surgery. World J Surg 2010;34:2487–9.
[7] Asakuma M, Komeda K, Yamamoto M, et al. A concealed "Natural Orifice": umbilicus anatomy for minimally invasive surgery. Surg Innov 2019;26:46–9.
[8] Kaouk JH, Goel RK, Haber GP, et al. Robotic single-port transumbilical surgery in humans: initial report. BJU Int 2009;103:366–9.
[9] Fathi AH, Soltanian H, Saber AA. Surgical anatomy and morphologic variations of umbilical structures. Am Surg 2012;78:540–4.
[10] Safe techniques for abdominal access and wound closure in laparoscopic, surgery. Minim Invasive Ther Allied Technol 2001;10:41–6.
[11] Steinhauser G. The nature of navel fluff. Med Hypotheses 2009;72: 623–5.
[12] Sarma DP, Teruya B. 'Lint ball' omphalitis, a rare cause of umbilical discharge in an adult woman: a case report. Cases J 2009; 2:7785.
[13] Chamberlain RS, Sakpal SV. A comprehensive review of single-incision laparoscopic surgery (SILS) and natural orifice transluminal endoscopic surgery (NOTES) techniques for cholecystectomy. J Gastrointest Surg 2009;13:1733–40.
[14] Mouret P. How I developed laparoscopic cholecystectomy. Ann Acad Med Singapore 1996;25:744–7.
[15] Aprea G, Coppola Bottazzi E, Guida F, et al. Laparoendoscopic single site (LESS) versus classic video-laparoscopic cholecystectomy: a randomized prospective study. J Surg Res 2011;166:e109–12.
[16] Bucher P, Pugin F, Buchs NC, et al. Randomized clinical trial of laparoendoscopic single-site versus conventional laparoscopic cholecystectomy. Br J Surg 2011;98:1695–702.
[17] Lai EC, Yang GP, Tang CN, et al. Prospective randomized comparative study of single incision laparoscopic cholecystectomy versus conventional four-port laparoscopic cholecystectomy. Am J Surg 2011;202:254–8.
[18] Ma J, Cassera MA, Spaun GO, et al. Randomized controlled trial comparing single-port laparoscopic cholecystectomy and four-port laparoscopic cholecystectomy. Ann Surg 2011;254:22–7.
[19] Trastulli S, Cirocchi R, Desiderio J, et al. Systematic review and meta-analysis of randomized clinical trials comparing single-incision versus conventional laparoscopic cholecystectomy. Br J Surg 2013;100: 191–208.
[20] Antoniou SA, Garcia-Alamino JM, Hajibandeh S, et al. Single-incision surgery trocar-site hernia: an updated systematic review meta-analysis with trial sequential analysis by the Minimally Invasive Surgery Synthesis of Interventions Outcomes Network (MISSION). Surg Endosc 2018;32: 14–23.
[21] Antoniou SA, Morales-Conde S, Antoniou GA, et al. Single-incision laparoscopic surgery through the umbilicus is associated with a higher incidence of trocar-site hernia than conventional laparoscopy: a meta-analysis of randomized controlled trials. Hernia 2016;20:1–0.