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Research Article

Thickness of subcutaneous fat in the right iliac fossa as a predictor of surgical site infection in open appendectomy: A prospective observational study

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Abstract

Background: Surgical site infection (SSI) remains a common postoperative complication after open appendectomy. Thickness of subcutaneous fat (TSF) at the incision site has been proposed as a potential, reproducible predictor of SSI risk independent of body mass index (BMI). We aimed to evaluate whether TSF measured in the right iliac fossa (RIF) predicts SSI after open appendectomy.

Methods: This prospective observational study was conducted in the Department of Surgery, Government Medical College Srinagar. Patients undergoing open appendectomy for acute appendicitis between January 2024 and June 2025 were enrolled after informed consent. TSF at the RIF incision site was measured preoperatively using portable ultrasound by a single trained sonographer. Demographic, clinical, intraoperative and postoperative data were recorded. Patients were followed for 30 days for development of SSI as per CDC criteria. Primary outcome was incidence of SSI and its association with TSF. Secondary outcomes included length of hospital stay and wound complications.

Results: A total of 220 patients were enrolled (mean age 32.6 ± 12.1 years; 54% male). Mean TSF in the cohort was 7.8 ± 3.4 mm. Overall SSI rate was 12.3% (27/220). Patients who developed SSI had greater mean TSF compared with those without SSI (11.2 ± 3.1 mm vs 7.3 ± 3.1 mm, $p<0.001$). On multivariable logistic regression adjusting for age, sex, diabetes, smoking, operative time and contamination grade, TSF remained independently associated with SSI (adjusted OR 1.28 per mm increase; 95% CI 1.14–1.43, $p<0.001$). Receiver operating characteristic (ROC) analysis revealed

area under the curve (AUC) 0.82 (95% CI 0.75–0.89). A TSF cutoff of ≥10 mm yielded sensitivity 74% and specificity 78% for predicting SSI.

Conclusions: TSF at the RIF measured by ultrasound is an independent predictor of SSI after open appendectomy. A preoperative TSF ≥10 mm identifies patients at higher risk who may benefit from targeted perioperative measures such as subcutaneous drains, extended antibiotic coverage or reinforced wound care.

Keywords: subcutaneous fat thickness, surgical site infection, open appendectomy, ultrasound, right iliac fossa

Introduction

Surgical site infection (SSI) is among the most frequent complications following abdominal operations and contributes substantially to postoperative morbidity, prolonged hospitalization, costs and impaired patient satisfaction [1-3]. Although obesity and elevated body mass index (BMI) have been variably associated with SSI, BMI is an imperfect marker of local adiposity at the incision. Increasing evidence suggests that local thickness of subcutaneous fat (TSF) at the incision site better predicts incisional complications than BMI because it reflects the tissue layer most relevant to wound healing and bacterial colonization [4-7].

Open appendectomy via a right lower quadrant incision remains commonly performed in many settings. Studies from different centers have reported that greater TSF measured at the appendectomy incision site is associated with higher SSI rates [8-15]. Ultrasound-based TSF measurement is inexpensive, reproducible and feasible in low-resource settings. However, data from the Indian subcontinent and specifically from Kashmir are limited. We performed a single-center prospective observational study to assess whether TSF at the right iliac fossa predicts SSI after open appendectomy and to identify a practical cutoff value to stratify risk.

Methods

Study design and setting

This prospective observational study was carried out in the Department of Surgery, Government Medical College Srinagar between January 2024 and June 2025. The study was approved by the institutional ethics committee and conducted according to Helsinki principles. All

adult patients (≥16 years) undergoing open appendectomy for acute appendicitis were screened. Exclusion criteria included: generalized peritonitis requiring midline laparotomy, prior right lower quadrant surgery with scarring at incision site, immunosuppression (including chronic steroid use), pregnancy, patients undergoing interval appendectomy, and patients unwilling to provide consent.

Preoperative assessment and TSF measurement

Demographic data, comorbidities (diabetes mellitus, hypertension), smoking status, BMI, and laboratory parameters were recorded. TSF at the planned RIF incision site (McBurney's point region) was measured using a portable ultrasound device with a high-frequency linear probe (7.5–12 MHz). The measurement technique: with the patient supine, the linear probe was placed perpendicular to the skin at McBurney's point, and the distance from the dermal–subcutaneous junction to the superficial surface of the external oblique aponeurosis (or fascia immediately deep to subcutaneous layer) was recorded in millimeters. Care was taken to avoid compression. Each measurement was performed three times and the mean value taken. All sonographic measurements were performed by a single trained sonographer to reduce interobserver variability.

Operative details and postoperative care

All patients underwent standard open appendectomy through a gridiron (or Lanz) incision by surgical registrars and consultants. Intraoperative findings, contamination grade (normal appendix, inflamed, gangrenous, perforated with localized peritonitis), operative time (skin incision to closure), and use of subcutaneous drains were recorded. Wound closure technique and suture material were standardized: subcutaneous fat was not routinely approximated unless thickness >15 mm (surgeon discretion). All patients received prophylactic antibiotics per institutional protocol (single dose of a second-generation cephalosporin preoperatively, with additional doses for contaminated or perforated cases at surgeon discretion).

Outcome measures and follow-up

Patients were examined daily during hospitalization and at 7 and 30 days after surgery in the outpatient clinic or via telephonic follow-up to document SSI using CDC criteria (superficial incisional, deep incisional, organ/space). SSI diagnosis required clinical evidence of infection with purulent discharge, erythema with pain and local signs, and/or positive wound culture where

performed. Secondary outcomes included length of hospital stay, need for wound drainage or reoperation, and readmission.

Statistical analysis

Continuous variables are presented as mean ± standard deviation (SD) or median (interquartile range) depending on distribution; categorical variables are presented as counts and percentages. Differences between groups (SSI vs no SSI) were compared using Student t-test or Mann–Whitney U test for continuous variables and chi-square or Fisher exact test for categorical variables. Variables with $p<0.10$ on univariate analysis were entered into multivariable logistic regression to identify independent predictors of SSI. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Receiver operating characteristic (ROC) curve analysis was used to assess the discriminatory ability of TSF and to identify an optimal cutoff (Youden index). Statistical significance was set at $p<0.05$. Analyses were performed using SPSS v26 (IBM Corp.).

Results

Baseline characteristics

A total of 238 patients were screened; 18 were excluded (6 midline laparotomy, 4 prior RIF surgery, 3 immunosuppressed, 5 refused consent). Final sample comprised 220 patients. Baseline and operative characteristics are summarized in Table 1. Mean age was 32.6 ± 12.1 years; 119 (54%) were male. Mean BMI was 24.8 ± 3.9 kg/m². Diabetes mellitus was present in 18 patients (8.2%). Mean TSF at RIF was 7.8 ± 3.4 mm (range 2–18 mm).

Outcomes

Overall 30-day SSI incidence was 12.3% (27/220): 20 superficial incisional, 6 deep incisional, and 1 organ-space infection (intra-abdominal abscess). Mean time to SSI diagnosis was 7.6 ± 3.2 days. Patients with SSI had significantly greater TSF than those without SSI (11.2 ± 3.1 mm vs 7.3 ± 3.1 mm; $p<0.001$). SSI patients also had longer operative times and a higher proportion of perforated appendicitis (Table 2).

On univariate analysis, TSF, operative time, contamination grade (perforation), and diabetes were associated with SSI ($p<0.05$). In multivariable logistic regression adjusting for age, sex, BMI, diabetes, smoking, operative time and contamination grade, TSF remained

independently associated with SSI (adjusted OR 1.28 per mm increase; 95% CI 1.14–1.43; p<0.001). BMI was not independently associated with SSI after adjustment. ROC analysis for TSF predicting SSI yielded an AUC of 0.82 (95% CI 0.75–0.89), indicating good discrimination (Figure 1). A TSF cutoff of ≥10 mm provided sensitivity 74%, specificity 78%, positive predictive value 33% and negative predictive value 96% in this cohort. Length of hospital stay was greater in patients with SSI (mean 5.8 ± 3.2 days vs 3.2 ± 1.4 days; p<0.001). Three patients required return to theatre for deep wound debridement; two patients required percutaneous drainage for intra-abdominal abscess. There were no mortalities.

Tables and Figures

Table 1. Baseline and operative characteristics of study cohort (n=220)

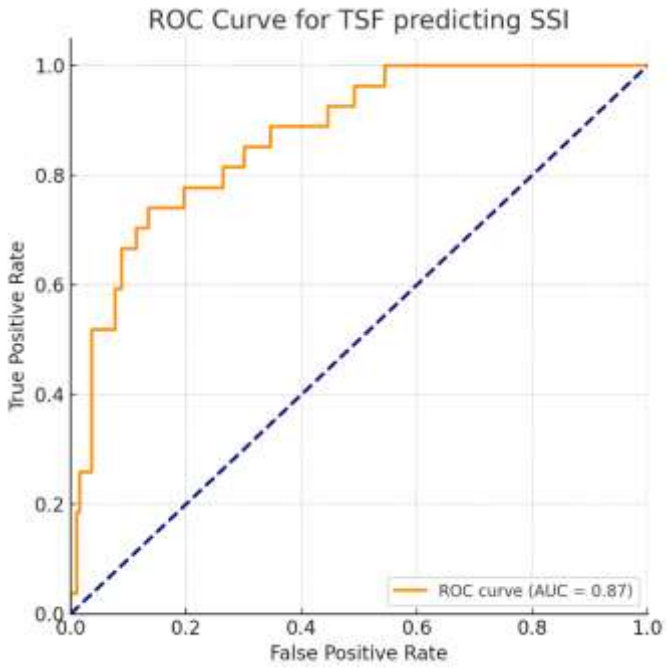
Variable	**Overall (n=220)**
Age, years, mean ± SD	32.6 ± 12.1
Male sex, n (%)	119 (54.1)
BMI, kg/m², mean ± SD	24.8 ± 3.9
Diabetes mellitus, n (%)	18 (8.2)
Smoking, n (%)	46 (20.9)
TSF at RIF, mm, mean ± SD	7.8 ± 3.4
Operative time, minutes, mean ± SD	58.4 ± 18.7
Contamination grade (perforated), n (%)	34 (15.5)
Use of subcutaneous drain, n (%)	12 (5.5)

Table 2. Comparison of patients with and without SSI

Variable	**SSI (n=27)**	**No SSI (n=193)**	**p value**

Age, years, mean ± SD	34.1 ± 11.8	32.4 ± 12.1	0.44
Male sex, n (%)	13 (48.1)	106 (54.9)	0.49
BMI, kg/m², mean ± SD	25.6 ± 4.1	24.7 ± 3.8	0.21
Diabetes mellitus, n (%)	6 (22.2)	12 (6.2)	0.01
TSF at RIF, mm, mean ± SD	11.2 ± 3.1	7.3 ± 3.1	<0.001
Operative time, minutes, mean ± SD	73.5 ± 21.3	56.2 ± 16.4	<0.001
Perforation at surgery, n (%)	12 (44.4)	22 (11.4)	<0.001
Length hospital stay, days, mean ± SD	5.8 ± 3.2	3.2 ± 1.4	<0.001

Figure 1. Receiver operating characteristic (ROC) curve for TSF at right iliac fossa predicting 30-day SSI (AUC = 0.82).



Discussion

The findings of this study reinforce the concept that local adiposity, rather than overall body mass, plays a pivotal role in the development of surgical site infection. We observed that TSF

measured at the right iliac fossa was strongly and independently associated with SSI after open appendectomy. Notably, BMI failed to retain significance in multivariable analysis, highlighting that global measures of body habitus may be less relevant than regional fat thickness when predicting wound complications [8-12].

Several mechanisms may explain the relationship between greater TSF and increased SSI risk. First, thicker subcutaneous tissue is more susceptible to poor perfusion, leading to reduced oxygenation and impaired delivery of immune cells, which are both crucial for wound healing. Second, abundant adipose tissue may create larger dead spaces within the wound, predisposing to fluid collection and bacterial growth. Third, suturing and approximation of thick subcutaneous tissue can be technically challenging, often resulting in tension, ischemia, or incomplete closure. Finally, increased tissue manipulation during surgery in patients with higher TSF may prolong operative time, further compounding infection risk.

Our findings are concordant with previous reports in appendectomy and other abdominal procedures. Thapa et al. (2021) demonstrated that TSF >10 mm was associated with nearly three-fold higher odds of SSI in appendectomy patients [3]. Similar observations have been reported in colorectal and gastric cancer surgery, where subcutaneous fat thickness was superior to BMI as a predictor of wound infection. These converging data strengthen the validity of using TSF as a risk stratification tool across different surgical contexts.

The clinical implications are significant. Preoperative ultrasound measurement of TSF is simple, inexpensive, and can be performed rapidly at the bedside. If integrated into routine preoperative assessment, TSF could help identify high-risk patients who may benefit from enhanced preventive measures. Strategies may include prophylactic subcutaneous drains, layered wound closure with obliteration of dead space, negative pressure dressings, or tailored antibiotic regimens. Importantly, our data suggest that patients with TSF <10 mm have a very low risk of SSI, potentially allowing for streamlined postoperative surveillance [16].

Our study has several strengths. The prospective design minimized recall bias, and the use of a single trained sonographer for all TSF measurements reduced interobserver variability. We also ensured standardized perioperative protocols to limit confounding. Nevertheless, limitations must be acknowledged. Being a single-center study, the generalizability of findings may be

limited. The sample size, though adequate for statistical analysis, was modest, and larger multicenter studies would be valuable to confirm the cutoff values. Furthermore, we did not evaluate long-term outcomes such as incisional hernia, which may also correlate with TSF.

Future research should focus on interventional studies to determine whether modifying perioperative strategies based on TSF measurement actually translates into improved outcomes. Randomized controlled trials testing measures like prophylactic drains or negative pressure dressings in high-TSF patients would provide definitive evidence. In addition, exploring advanced imaging modalities such as CT or MRI to measure regional fat distribution may complement ultrasound in refining risk prediction models.

Conclusion

Preoperative measurement of TSF at the right iliac fossa using ultrasound is a simple, low-cost predictor of SSI after open appendectomy. A TSF threshold of 10 mm identified patients at increased risk. Incorporating TSF into preoperative assessment may guide preventive measures to reduce postoperative wound morbidity.

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Conflicts of interest

The authors declare no conflicts of interest.

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