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Original Article

Subcutaneous Fat Thickness as a Predictor for Surgical Site Infection in Patients Undergoing Open Appendectomy

Nishita Maheshwari[1], Sharath Krishna[2], Dilip Apturkar[3]

[1]Resident, Department of General Surgery, DBVP Rural Medical College, Loni, Maharashtra, India, [2]Assistant Professor, Department of General Surgery, DBVP Rural Medical College, Loni, Maharashtra, India, [3]Professor and Head, Department of General Surgery, DBVP Rural Medical College, Loni, Maharashtra, India

Abstract

Objective: Acute appendicitis is one of the most common causes of an acute abdomen and is one of the most frequently performed abdominal surgeries. One of the early post-operative complications of appendectomy is surgical site infection (SSI) which is a major medical concern as it increases the burden on the patient and the health-care system. Obesity is an independent risk factor for SSI. Body mass index is most commonly used to define obesity but is a non-specific indicator for the risk of SSI. Thickness of the subcutaneous fat pad is a more targeted measure to assess the risk of SSI. The aim is to study the association between the thickness of subcutaneous fat and SSIs in open appendectomy wounds.

Methods: With a sample size of 128, the study was carried out at Pravara Rural Hospital, Loni, from September 2023 to December 2024. All patients who underwent emergency or elective open appendectomy during the time period were included in the study and had an abdominal USG prior to surgery to gauge the thickness of the subcutaneous fat pad in the right iliac fossa and were followed for 1 month for SSIs.

Results: The data indicate an association between increased rates of SSIs and patients who had thicker subcutaneous fat pad at the site of the incision.

Key words: Appendicitis, Open appendectomy, Subcutaneous fat thickness, Surgical site infection

INTRODUCTION

Appendicitis is inflammation of the appendix, with its highest occurrence being observed in the second and third decades of life. There is a slightly increased male preponderance as compared to females. Appendicitis can at times present as a chronic condition, but most often patients present acutely.[1]

Acute appendicitis stands as one of the most common causes of acute abdominal conditions, which, if left untreated, can lead to a gangrenous appendix leading to appendicular perforation. This in turn leads to further complications such as generalized peritonitis, localized phlegmon, or abscess formation.[2] Surgical intervention has remained the conventional treatment approach. Hence, appendectomies are one of the most frequently performed abdominal surgeries.[3]

The primary post-operative complication commonly encountered is surgical site infection (SSI). Defined as infections occurring up to 30 days after surgery affecting either the incision or deep tissue at the operation site, SSIs are a major medical concern that arise postoperatively and increase the burden on the patient and the health-care system, negatively impacting the patient's health-related quality of life.[4]

SSIs can result from various factors, such as malnutrition, wound class, lack of aseptic surgical practices, advanced age, and others.[5] Obesity is an independent risk factor for SSI.[6] Body mass index is most commonly used to

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Corresponding Author: Dr. Nishita Maheshwari, Department of General Surgery, DBVP Rural Medical College, Loni, Maharashtra, India.

define obesity but is a non-specific indicator for the risk of SSI. Thickness of the subcutaneous fat pad is a more targeted measure to assess the risk of SSI.[7] Various mechanisms have been proposed to explain how obesity may contribute to the increased incidence of SSIs which include impaired immune function, reduced oxygen levels in surgical wounds, inadequate tissue penetration of perioperative antibiotics, prolonged operative time, increased operative blood loss, and obesity-related decreased immune response.[8]

The goal of the research is to study the association between the thickness of subcutaneous fat at the site of the incision and SSI in open appendectomy wounds.

MATERIALS AND METHODS

With a sample size of 128, the study was carried out at Pravara Rural Hospital, DBVP Rural Medical College, Loni, from September 2022 to December 2023. All patients who underwent emergency or elective open appendectomy during the time satisfying the inclusion criteria were included in the study.

Inclusion Criteria

- Patients diagnosed as appendicitis (acute/chronic/subacute) were included in the study.

Exclusion Criteria

The following criteria were excluded from the study:

- Immunocompromised patients
- Patients having undergone previous abdominal surgeries.

All patients diagnosed with appendicitis had an abdominal USG to gauge the thickness of the subcutaneous fat pad in the right iliac fossa before surgery and followed postoperatively for SSI for 1 month.

The diagnosis was determined based on the criteria outlined by the Centers for Disease Control and Prevention in 1999 for defining a SSI.[9]

Other possible factors that might play a role in the development of incisional SSIs were also considered.

Each patient received a single dose of intravenous ceftriaxone before and after the surgical procedure. Wound infection was considered if there was discharge from the wound, either serous or purulent, with or without accompanying signs of inflammation or if there was visible wound dehiscence. Cultures from the wounds were sent to identify the organism isolated.

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 22.0 (SPSS, Chicago, IL, USA). Continuous parametric variables are expressed as the mean ± Standard deviation, while non-parametric data are presented as 5–95% confidence intervals. Unpaired *t*-tests were employed to compare parametric variables, and the Chi-square test was utilized for non-parametric data. Univariate and multivariate logistic regression analyses were executed to identify potential predictors of post-operative SSIs.

RESULTS

A total of 128 patients were included in the study with a mean age of 32 years and age distribution from 11 to 77 years. Of these 79 were male (61.7%) and 49 were female (38.3%). The mean subcutaneous fat thickness was 6.67 mm. The prevalence of superficial SSI among these was 36.7% (47 out of 128 patients had SSI). None of the patients experienced deep incisional or organ space SSIs.

Age

In the given sample of 128 participants, the patients were divided into three groups arbitrarily based on their age: <30 years, 30–50 years, and more than 50 years.

There were 70 subjects in the age group of <30 years, 45 subjects in the age group of 30–50 years, and 13 subjects in the age group of more than 50 years.

SSI was noted in 21 subjects in the age group of <30 years with 19 in the group of 30–50 years and seven in the group of more than 50 years.

Sex

In the present study, there were 79 males and 49 females [Figure 1].

The incidence of SSI was observed in 20 males (25.3%) and 27 females (55.1%).

Table 1: Distribution of patients according to subcut. fat thickness

Subcut. fat thickness	Total patients	Patients with SSI	Patients without SSI
<5.5 mm	25	7	18
Between 5.5 and 7.5 mm	63	19	44
More than 7.5 mm	40	21	19
Total	128	47	81

SSI: Surgical site infection

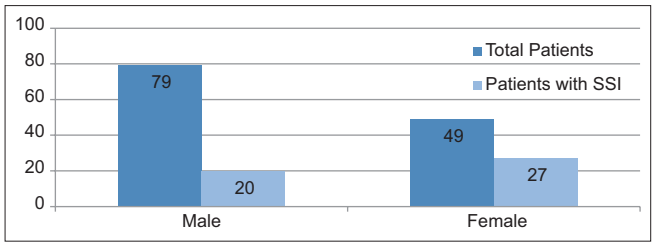

Figure 1: Sex distribution

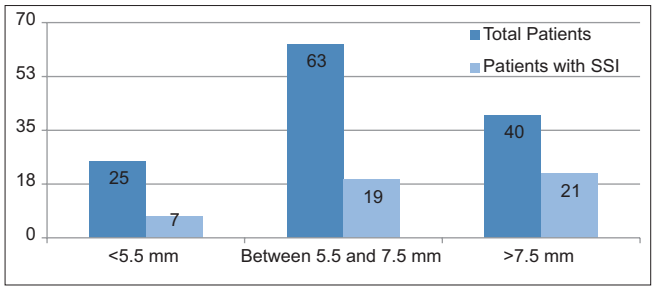

Figure 2: Patient diagnosis distribution

Subcutaneous Fat Thickness

Three groups based on the thickness of subcutaneous fat were identified: I – 5.5 mm and less, II – 5.5–7.5 mm, and III – >7.5 mm [Table 1 and Figure 2].

Among the 128 subjects, there were 25 subjects in the group of thickness <5.5 mm, 63 subjects in the group of thickness between 5.5 mm and 7.5 mm, and 40 subjects in the group of thickness more than 7.5 mm. SSI was noted in 11 subjects in the first group (28%), with 15 in the second group (30%) and 21 in the third group (52%).

Diagnosis

In the present study of 128 participants, patients diagnosed with acute appendicitis underwent emergency open appendectomy while those diagnosed with subacute or chronic appendicitis underwent elective surgeries [Figure 3].

There were 76 patients diagnosed with acute appendicitis, of which 24 developed SSI. 27 patients were diagnosed as subacute appendicitis and 25 patients as chronic appendicitis. Of these, 8 and 15 had SSIs, respectively.

Organisms Isolated

Out of 128 patients, 47 developed SSIs. Cultures from those with SSIs isolated the following organisms: *Escherichia coli* in 27 of the patients (57.5%), *Klebsiella* in 12 patients (25.5%), and *Pseudomonas* in 8 patients (17%).

Chi-squared test was done for association between subcutaneous fat pad thickness and SSI. *P*-value was 0.0435 and it was noted that the variables are significantly associated.

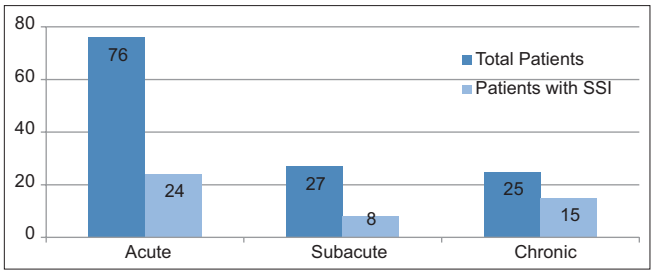

Figure 3: Subcutaneous fat thickness distribution

Chi-squared test was done for the trend of association between the two. *P*-value was 0.0267 and it was noted that there is a significant linear association between the variables [Table 2].

DISCUSSION

The focus of the study was to examine the relationship between subcutaneous fat thickness and incisional SSIs in patients undergoing open appendectomy. The prevalence of incisional SSIs in the study was 36.7%.

The findings indicate that subcutaneous fat thickness serves as a predictor for incisional SSIs in patients undergoing open appendectomy. The highest occurrence was observed in patients with subcutaneous fat thickness >7.5 mm (52%), followed by those with thickness between 5.5 and 7.5 mm (30%) and those with thickness <5.5 mm (28%).

The increased thickness of subcutaneous fat at the surgical site may necessitate an extended operative time for the surgeon. This can be attributed to the need for a longer incision, wider dissection, and increased retraction due to the heightened difficulty posed by the increased fat presence during the surgery.[10] Extended operative time can elevate the vulnerability of the wound to infections by increasing the exposure to potential contaminants and reducing the concentration of antibiotics within the tissues.[11]

While the most common age group affected by acute appendicitis was <30 years, the age group over 50 years exhibited a higher incidence of SSI of 54%. In ages <30 years, the incidence was 30%. Several considerations in the elderly, such as underlying comorbid illnesses, have been recognized as risk factors for SSIs.[12]

There were 76 patients diagnosed with acute appendicitis who underwent emergency open appendectomy while the rest underwent appendectomy as an elective procedure. The rate of SSI was more in cases of emergency surgeries being 32%. Studies have demonstrated a significant association

Table 2: Correlation between subcutaneous fat thickness and SSIs

	n	Mean	Minimum subcut. thickness (mm)	Maximum subcut. thickness (mm)	Standard deviation
Patients with SSI	47	6.7787	3.6	10	1.481932046
Patients without SSI	81	6.6024	3.5	9.6	1.485315784
Total	128	6.6671			

SSI: Surgical site infection

between emergency surgery and higher rates of SSIs which corresponds with the findings of the study.[13]

E. coli was the most common isolated organism causing SSI in these patients accounting for 58% of the cases, followed by *Klebsiella* causing around 25% cases, and *Pseudomonas* accounting for 17% cases. This is consistent with other studies which have found *E. coli* to be one of the most common pathogens causing SSIs.[14]

This study has its own limitations. Ultrasound (USG) is operator-dependent, making standardization of the measurement technique difficult. In our study, despite different radiologists performing the USG, the measurement of subcutaneous fat thickness proved to be a significant predictor for incisional SSIs with $P = 0.0435$. Several other risk factors for SSI were not assessed in this study, such as anemia, pre-operative levels of albumin, patient frailty, and comorbid conditions such as diabetes and history of smoking which are also risk factors for SSIs.[13]

CONCLUSION

The thickness of subcutaneous fat serves as a more targeted measure of obesity and proves to be a valuable clinical indicator for anticipating the likelihood of post-operative superficial incisional SSIs in patients undergoing open appendectomy. The risk of developing a superficial wound site infection rises in tandem with the increasing thickness of subcutaneous fat at the incision site.

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analyzed during the present study are available from the corresponding author on reasonable request.

STATEMENTS AND DECLARATIONS

This is an original piece of work done at Pravara Rural Hospital, DBVP Rural Medical College, Loni. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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