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Original Article

Correlation of Lumbar Spine Fat Thickness and Surgical Site Infection in Degenerative Lumbar Spine Surgery

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Introduction

Surgical site infection (SSI) is a serious and common complication following any surgery. Patients undergoing lumbar surgery have a higher risk for SSI. Therefore, it is essential to accurately identify the risk factors of SSIs to prevent them. There is an insufficient number of studies internationally and only one to our knowledge nationally that studied the correlation between lumbar fat thickness and SSI in patients undergoing lumbar spine surgery. Our aim was to identify the correlation between lumbar fat thickness and SSI and determine its predictive value compared to other risk factors in predicting the incidence of SSI.

Methods

This retrospective cohort study involved all patients aged 18 and above who underwent primary elective degenerative lumbar spine surgery in National Guard Health Affairs (NGHA) from 2016 to 2020 at King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia. All trauma and oncology cases, patients with previous spine surgery, non-instrumented cases, and emergency cases without preoperative radiological images were excluded. The pre-operative and post-operative measurements were assessed using the sagittal MRI images on the T1 view to measure the fat length of the lumbar spine from L2 to S1. Two observers evaluated the films, and the average measurement was documented for each level.

Results

151 patients were included in our study, four of whom developed SSI. When comparing the demographics of both groups, BMI was found to be a significant variable between both groups, with a P-value of 0.013. However, there was no significance regarding age, gender, DM, HTN, steroid use, and level of stay for each group. Furthermore, there was no significance in all vertebrae levels except for L4 fat thickness, which was significantly higher in the SSI group with a P value of 0.0264.

Conclusion

Surgical site infection (SSI) is a serious and common complication following any surgical operation. Patients undergoing lumbar surgery have a higher risk for SSI. In this study, we concluded that an increased L4 fat thickness was a significant predictor of SSI.

Keywords: *Lumbar fat thickness, Surgical site infection, Lumbar surgery, MRI fat thickness*

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1. Introduction

Surgical site infection (SSI) is defined by the Centers for Disease Control and Prevention (CDC) as an infection related to an operative procedure that occurs within 30 days of the procedure or 90 days if prosthetic material is implanted at surgery[1]. It is one of the serious and common complications following any surgical operation. It is associated with unfavorable surgical outcomes and higher morbidity, poor quality of life, extended hospital length of stay, mortality, and health care cost[1,2]. A study reported that the adipose index was significantly greater in patients who underwent posterior lumbar spine surgery and had a higher risk for deep surgical site infections[3]. Surgeons have tried several methods to minimize and prevent the risk of surgical site infections, such as the use of prophylactic antibiotics, extensive preoperative sterilization methods modifying their surgical techniques and minimizing incisions as much as possible[4]. Despite all these efforts, the incidence of SSI is still an active issue among surgeons. Therefore, it is essential to accurately identify the risk factors to predict the possibility of infections and try to prevent them. Multiple studies have already linked a variety of risk factors to SSI, such as advanced age, male gender, obesity, previous spinal surgery, malnutrition, diabetes, smoking, spinal trauma, corticosteroid use, posterior surgical approach, tumor resection, surgery involving sacrum, dural tear, conventional open spinal surgery, increased intra-operative estimated blood loss, and prolonged operating time[3,5,6].

In the medical field, obesity has been identified as a body mass index greater than thirty[6] and although many researchers have linked the increase of BMI with the risk of surgical site infection, only recently have they started to focus on the correlation between the thickness of subcutaneous fat at the surgical site and the incidence of surgical site infection.

There is still, however, an insufficient number of studies internationally, and nationally , only one to our knowledge in Saudi Arabia that studied the correlation between lumbar fat thickness and SSI in patients undergoing lumbar spine surgery.

The study aims to identify the correlation between lumbar fat thickness and SSI and determine its predictive value compared to other risk factors in predicting the incidence of SSI.

2. Methods

2.1. Study Design and Population

This retrospective cohort study involves all patients aged 18 and above who underwent primary elective degenerative lumbar spine surgery in NGHA from 2016 to 2020 at King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia. All trauma and oncology cases were excluded because those patients did not have the option of reducing their weight before their surgery. Moreover, patients with previous spine surgery, non-instrumented cases, and emergency cases without preoperative radiological images were also excluded.

2.2. Data Collection

All patients who had a primary elective degenerative lumbar spine surgery were reviewed. As such, the sampling technique used was total population inclusion. The patients were identified from medical charts and databases. The pre-operative and post-operative measurements were assessed. MRI was the radiological test used to identify and measure the fat length of the lumbar spine. Two observers assessed the films, and the average measurement was documented for each level. The subcutaneous fat thickness was measured using the Sagittal MRI on the T1 view, and the included levels were from L2 to S1. The measurement starts from the edge of each spinous process level to the end of the fat, excluding the skin, using a dead horizontal line as shown in figure1.

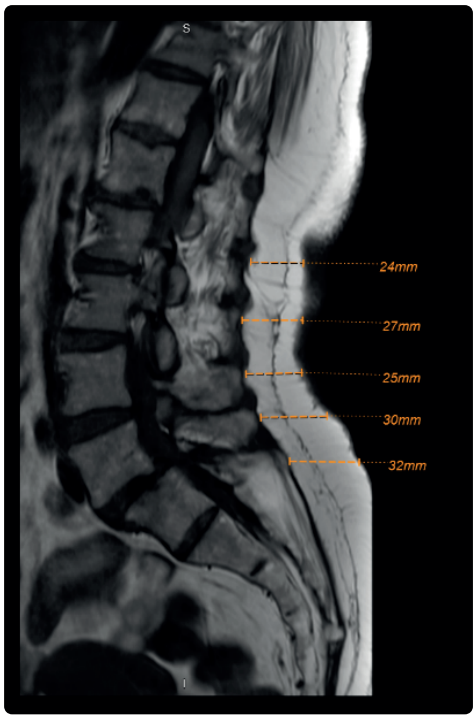

Figure 1. Lumbar spine MRI Measurement.

The participants were split into two groups: obese and non-obese. According to the World Health Organization, obesity is defined in adults, as a body mass index (BMI) of over 30. The data collection form included: demographics (gender, age, BMI), comorbidities: DM, HTN, IHD, COPD, smoking, H/O steroid use, diagnosis, spine location, instrumentations, number of levels, surgery date, MRI date, fat thickness: L2, L3, L4, L5, S1, approach, surgical time, OPEN vs MISS, length of hospital stay, ASA score, perioperative blood transfusion, use of epidural steroid injection within 3m before surgery, post-op wound infection, post-op day of diagnosis, type of wound infection, management with oral antibiotics, management with IV antibiotics, and management with debridement.

2.3. Statistical Analysis

Categorical variables such as gender, smoking status, etc., were described as frequency and proportions; while the continuous variables such as age, weight, and length of stay were presented by means and standard deviation, or median and IQR. All demographics and clinical characteristics were compared across the study groups using a t-test or chi-square test for continuous and categorical variables, respectively. All results were reported in terms of differences in proportions and means, with corresponding 95% confidence intervals (CI) and p-values. Significance was considered at p=0.05. The interobserver agreement was analyzed using the intraclass correlation coefficient (ICC). The risk factors for developing SSI were analyzed using logistic regression. The outcome variable was SSI (yes/no). The independent variables were age, gender, BMI, etc. Results were reported as OR, 95% CI and p-value. The data was analyzed using SAS V9.0.

3. Results

We initially started with a total of 200 patients who underwent primary elective degenerative lumbar spine surgery during the period of 2016 to 2020. Upon

further filtration, all patients with no instrumentation and those with incomplete, poor quality, or missing MRIs were excluded from our study. A total of 49 patients were excluded, and we resulted in a total of 151 patients who were included in our study. Patients' demographics and clinical characteristics are presented in **Table 1**. Among the 151 patients, 92 (61%) were female, and 59 (39%) were male. The average age of the participants was 61±13.4 years old. The patients were divided based on their BMI into two groups, obese and non-obese, with a mean BMI to be 32.1. Only 10 (6.6%) patients were smokers. Hypertension was the highest recorded comorbidity with 84 (55.6%) patients, followed by diabetes with 82 (54.3%).

All patients underwent a posterior approach. Additionally, 148 (98%) patients underwent an open technique surgery, while an MISS technique was only used in 3 (2%) patients. All the patients received a prophylactic antibiotic dose prior to surgery and received three post operative doses as well. Nine (6%) patients had received a perioperative blood transfusion. The level of stay for each group was calculated by including the total length of stay for the noninfected from surgery till discharged and till the day infections appeared for the infected group. The average level of stay for the noninfected was 11, and the infected group was 13 days with no significance (P-value of 0.2933) is demonstrated in **Table 2**.

Out of the 151 patients in our study, only four (2.6%) patients developed a post-op SSI. All of them were confirmed by positive tissue cultures. It showed two patients to have Escherichia coli, one patient with klebsiella pneumoniae, and one patient with Acinetobacter baumannii. All four patients were females and were diagnosed with diabetes mellitus. Furthermore, only one patient was diagnosed with HTN and none of them were smokers. The average subcutaneous fat thickness of L2, L3, L4, L5, S1 in the non-infected group (97.4%, n=147/151) was 18.8mm, 32.4mm, 32.8mm, 32.9mm, and 32.9mm, respectively. On the other hand, the patients that developed a post-op SSI recorded a higher average on all levels with; 34.2mm, 38mm, 50.9mm, 43.1mm, and 42mm, respectively. Each level with the average for patients that developed an SSI and patients that did not develop an SSI is shown in **Table 3.**

In addition, an open surgical technique was used in all four patients. The diagnosis of infection was made within 30 days for the four patients. Three (75%/) patients suffered from a deep wound infection, and one (25%) patient developed wound dehiscence. All four patients were treated with IV antibiotics, with an average of 33.5 days. Two patients were treated with oral antibiotics following the IV treatment for 7 days. Finally, all patients underwent a wound irrigation and debridement procedure while patients were taking the antibiotics course.

When comparing the infected group with the non-infected group, we found that there was a significant association between post-operative wound infection and the patient's BMI, with a mean average BMI of 39.29 among the infected group in comparison to 31.94 for the non-infected group with a significant p-value of 0.0131. There was no significance in all vertebrae levels except for L4. L4 fat thickness was significantly associated with the development of SSI, with an average of 50.95 mm in the infected group (P> 0.0264). The mean L4 fat thickness of patients that were not infected was 32.8 mm.

4. Discussion

Surgical site infection remains a common complication following spinal procedures. Many previous studies have discussed multiple factors that are associated with surgical site infection, for the incidence of SSI is an important factor of the quality management following every procedure. Moreover, by studying the risks of developing SSI, pre-operative measures can be taken to prevent and monitor this

Table 1: Demographics	Non-SSI	SSI	P-value
Gender:			
• **Male**	59 (39%)	0 (0%)	1.0000
• **Female**	88 (58.28%)	4 (2.65%)	0.1561
Smoking	10 (6.62%)	0 (0%)	1.0000
Comorbidities:			
• **Hypertension**	81 (53.64%)	3 (1.99%)	0.6297
• **Diabetes**	78 (51.6%)	4 (2.65%)	0.1256
• **Ischemic Heart Disease**	9 (5.96%)	0 (0%)	1.0000
• **Steroid Use**	6 (3.97%)	1 (0.66%)	0.1746
Age:			
• **Mean**	61.24	60.25	0.7901
• **Median**	62	61	
BMI:			0.0131
• **Mean**	31.94	39.29	
• **Median**	32	38	

Table 1. Data summarizes demographics and outcome of lumbar spine surgery.

Table 2:	Non-SSI	SSI	P-value
Number of levels:			0.2044
• **1**	64 (42.38%)	0 (0%)	1.0000
• **2**	68 (45.03%)	3 (1.99%)	
• **3**	10 (6.62%)	1 (0.66%)	
• **4**	2 (1.32%)	0 (0%)	1.0000
• **More than 4**	3 (1.99%)	0 (0%)	1.0000
OPEN	144 (95.36%)	4 (2.65%)	0.7729
MISS	3 (1.99%)	0 (0%)	1.0000
Perioperative Blood Transfusion:			0.2199
• **Yes**	8 (5.30%)	1 (0.66%)	
• **No**	139 (92.05%)	3 (1.99%)	
LOS:	11	13	0.2933

Table 2. Data summarizes operative and perioperative variables.

complication. One of the observed risk factors was the thickness of subcutaneous fat.

Previous studies showed Diabetes Mellitus (DM) to be an independent risk factor for the development of SSI[8–10]. One study has reported that all patients with DM have an increased 2.9-fold risk of developing SSI postoperatively[5]. Hence, one of the DM complications is microangiopathies which will lead to a delay in wound healing[11]. However, in our study, there was no significant correlation between SSI and DM, but all four patients that developed an SSI had DM, which may be due to having a small sample size.

Table3:	Non-SSI	SSI	P-value
Fat thickness average:			
L2	18.88	34.23	0.0631
L3	32.4	38.23	0.1253
L4	32.8	50.95	0.0264
L5	32.9	43.15	0.0735
S1	32.9	42.03	0.0690

Table 3. Data describing fat thickness average of lumbar spine surgery patients.

A study investigating the risk factors for deep SSI in spinal surgery found that an ASA score of more than or equal to three is a significant risk factor for developing an SSI[12]. Similarly, three out of four patients that developed an SSI had an ASA score of more than or equal to three, and there was a significant association between the ASA score and developing an SSI (P=0.05).

The association between high BMI and the development of SSI has been highlighted in many different studies. A meta-analysis that was published in 2018, had reported that the risk of SSI increased 9.75-fold for patients with obesity. Similarly, a retrospective analysis of the American College of Surgeons National Surgeons Quality Improvement Program (NSQIP) database noted that in the obese population, there is a significantly higher risk of surgical site infection[13]. In addition, Marquez-Lara et al reported that the risk of superficial wound infection was associated with a BMI>30 kg/m[14]. In another retrospective cohort review, patients who underwent one to three-level lumbar fusion surgery with a BMI greater than 30 were also found to have an increased risk of developing SSI[15]. Likewise, our research has shown that patients with a higher BMI had a significant correlation with the occurrence of SSI. Following the closure of a surgical wound, patients with a higher BMI have thick subcutaneous adipose layers that form a dead space which results in a localized wound infection due to local fat necrosis. All in all, patients with a high BMI are recommended for pre-operative optimization of their weight, which will contribute to a lower risk of developing an SSI.

Multiple studies in the literature have recently addressed the idea that body mass distribution, rather than BMI, might be a better predictor of SSI. However, there is an insufficient number of studies internationally and only one to our knowledge nationally that studied the correlation between lumbar fat thickness and SSI. In the national study that was published in the International Journal of Spine Surgery on July 2022, they reported a significant association of SSI with subcutaneous fat thickness measured on erect radiographs[16]. Another multicenter research assessed adipose index correlation with deep SSI and concluded that increased adipose tissue is an independent risk that was significantly associated with developing deep SSI. Therefore, it deserves more attention for risk stratification in pre-operative assessment and planning[3].

One study found that for every 1-mm thickness of L4 subcutaneous fat, a 6% increase occurred in the odds of developing a postoperative SSI. Our study lends further support to their thesis that subcutaneous fat thickness plays a role in developing an SSI. In our study we found that having a high L4 fat thickness measured by MRI was a significant risk factor for

developing SSI post-operatively. Additionally, a Chinese study investigated the reasons behind this significance and concluded that excess fat tissue in the surgical region might increase the difficulty and duration of the procedure due to a lack of adequate exposure to the surgical site[17].

Limitations

One of the limitations is that it is a retrospective study and depends on the accuracy of documentation. Another limitation was the small sample size in our study as it was done in a single center by multiple surgeons and that many cases were excluded due to incomplete or insignificant MRIs, for the dorsal fat thickness is not always entirely visualized on routine imaging. Nevertheless, with these findings, we think there is a need for a further future national study to increase the sample size and accurately look into the significance of fat thickness as a risk factor and predictor for SSI.

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References

[1] Whitehouse JD, Friedman ND, Kirkland KB, Richardson WJ, Sexton DJ. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital: adverse quality of life, excess length of stay, and extra cost. *Infect Control Hosp Epidemiol.* 2002 Apr;23(4):183–9.

[2] Blumberg TJ, Woelber E, Bellabarba C, Bransford R, Spina N. Predictors of increased cost and length of stay in the treatment of postoperative spine surgical site infection. Spine J. 2018 Feb;18(2):300-306. doi: 10.1016/j.spinee.2017.07.173. Epub 2017 Jul 21. PMID: 28739477.

[3] Gupta VK, Zhou Y, Manson JF, Watt JP. Radiographic spine adipose index: an independent risk factor for deep surgical site infection after posterior instrumented lumbar fusion. *Spine J.* 2021 Oct;21(10):1711–7.

[4] Blood AG, Sandoval MF, Burger E, Halverson-Carpenter K. Risk and Protective Factors Associated with Surgical Infections among Spine Patients. *Surg Infect (Larchmt).* 2017 Apr;18(3):234-249.

[5] Zhang L, Li EN. Risk factors for surgical site infection following lumbar spinal surgery: a meta-analysis. *Ther Clin Risk Manag.* 2018 Oct;14:2161–9.

[6] Mehta AI, Babu R, Karikari IO, Grunch B, Agarwal VJ, Owens TR, et al. 2012 Young Investigator Award winner: the distribution of body mass as a significant risk factor for lumbar spinal fusion postoperative infections. *Spine.* 2012 Sep;37(19):1652–6.

[7] Yao R, Zhou H, Choma TJ, Kwon BK, Street J. Surgical Site Infection in Spine Surgery: Who Is at Risk? *Global Spine J.* 2018 Dec;8(4 Suppl):5S–30S.

[8] Wimmer C, Gluch H, Franzreb M, Ogon M. Predisposing factors for infection in spine surgery: a survey of 850 spinal procedures. *J Spinal Disord.* 1998 Apr;11(2):124–8.

[9] Koutsoumbelis S, Hughes AP, Girardi FP, Cammisa FP Jr, Finerty EA, Nguyen JT, et al. Risk factors for postoperative infection following posterior lumbar instrumented arthrodesis. *J Bone Joint Surg Am.* 2011 Sep;93(17):1627–33.

[10] Lee JJ, Odeh KI, Holcombe SA, Patel RD, Wang SC, Goulet JA, et al. Fat Thickness as a Risk Factor for Infection in Lumbar Spine Surgery. Orthopedics. 2016 Nov;39(6):e1124–8.

[11] Salazar JJ, Ennis WJ, Koh TJ. Diabetes medications: Impact on inflammation and wound healing. *J Diabetes Complications.* 2016 May-Jun;30(4):746-52.

[12] 12. Ogihara S, Yamazaki T, Shiibashi M, Chikuda H, Maruyama T, Miyoshi K, Inanami H, Oshima Y, Azuma S, Kawamura N, Yamakawa K, Hara N, Morii J, Okazaki R, Takeshita Y, Tanaka S, Saita K. Risk factors for deep surgical site infection following posterior instrumented fusion for degenerative diseases in the thoracic and/or lumbar spine: a multicenter, observational cohort study of 2913 consecutive cases. *Eur Spine J.* 2021 Jun;30(6):1756-https://doi.org/10.1007/s00586-020-06609-y.

[13] Lim S, Edelstein AI, Patel AA, Kim BD, Kim JYS. Risk Factors for Postoperative Infections After Single-Level Lumbar Fusion Surgery. Spine (Phila Pa 1976). 2018 Feb

1;43(3):215-222. doi: 10.1097/BRS.0000000000000608. PMID: 25271498.

[14] Marquez-Lara A, Nandyala SV, Sankaranarayanan S, Noureldin M, Singh K. Body mass index as a predictor of complications and mortality after lumbar spine surgery. *Spine.* 2014 May;39(10):798–804.

[15] De la Garza-Ramos R, Bydon M, Abt NB, Sciubba DM, Wolinsky JP, Bydon A, et al. The impact of obesity on short- and long-term outcomes after lumbar fusion. *Spine.* 2015 Jan;40(1):56–61.

[16] AlSaleh K, Aldowesh A, Alqhtani M, Alageel M, AlZakri A, Alrehaili O, et al. Subcutaneous Fat Thickness on Erect Radiographs Is a Predictor of Infection Following Elective Posterior Lumbar Fusion. Int J Spine Surg. 2022 Jul;16(4):660–5. ; Epub ahead of print.

[17] Sang C, Chen X, Ren H, Meng Z, Jiang J, Qin Y. Correlation between lumbar multifidus fat infiltration and lumbar postoperative infection: a retrospective case-control study. BMC Surg. 2020 Feb;20(1):35.