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THE IMPORTANCE OF SUBCUTANEOUS TISSUE THICKNESS FOR THE OCCURRENCE OF SURGICAL SITE INFECTION AFTER LUMBAR DISC SURGERY

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ABSTRACT

Objective: Previous studies have shown that the length of the surgical path is important in surgical wound infection after a major lumbar surgery. We investigated for the first time the relationship between wound infection occurrence after lumbar disc surgery and subcutaneous tissue thickness.

Materials and Methods: We retrospectively identified 1,275 patients who underwent lumbar disc surgery between 2015 and 2020. Of these, 32 patients were hospitalised with a diagnosis of surgical superficial or deep wound infection. Demographic data, comorbidities, body mass index and body surface areas (BSAs) of the patients were recorded. Subcutaneous adipose tissue thickness and distance from the lamina to the skin were measured on magnetic resonance imaging examinations. Results were compared with that of the control group.

Results: Superficial and deep wound infections were detected in 62.5% and 37.5% of patients, respectively. Age (p=0.182), comorbidities (p=0.425), body mass index (p=0.182), BSA (p=0.569) and subcutaneous adipose tissue (p=0.110) did not contribute to the occurrence of wound infection after lumbar disc surgery. However, the distance between the lamina and skin (p=0.017) was found to be statistically different in women with a wound infection.

Conclusion: We found that that a long distance between the lamina and skin in women might be a risk factor for the occurrence of surgical wound infections.

Keywords: Discectomy, infection, wound, subcutaneous, surgical

INTRODUCTION

Surgical site infection (SSI) after discectomy is rare, but debilitating and potentially life-threatening ranging from 0.09% to 2.1%[1-5]. It also significantly reduces patient satisfaction due to re-hospitalisation[6] and increased length of hospital stay[7]. Despite intensive studies to identify its predisposing risk factors, it has not yet been fully elucidated[8,9]. Advanced age; smoking; comorbidities such as diabetes, hypertension, etc.; steroids use and surgical-related causes have been listed as risk factors[1,2,10-13].

The body mass index (BMI) has for long been used in spinal surgery as a parameter to predict the occurrence of SSI[5,11-13]. Growing evidence from studies indicates that a high BMI contributes to reoperation[14], and SSI occurrence[8]. However, it was suggested that the definition of obesity using the BMI did not accurately reflect the regional adipose tissue because it did not take into account the presence of muscle tissue[15]. To solve this problem, some claimed that the thickness of the subcutaneous tissues in the surgical pathway, rather than the fat distribution of the whole body, could be an important causal factor[16-19] Mehta et al.[16] evaluated the subcutaneous fat tissue (SFT) thickness and distance from the lamina to the skin (DLS) in patients with spinal who developed SSI. They suggested that SFT thickness and DLS provided stronger data to predict the likelihood of SSI occurrence, which was confirmed by others with similar data[17,19].

Therefore, we investigated the effects of BMI, body surface area (BSA), SFT and DLS on postoperative SSI occurrence in patients with lumbar disc surgery.

MATERIALS AND METHODS

Patients who underwent microdiscectomy with a diagnosis of lumbar disc herniation (LDH) between 2015 and 2020 and

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subsequently developed SSI were retrospectively analysed. We found that 32 patients developed SSI, which was classified as either superficial or deep. BMI, BSA, SFT and DLS were measured in all the patients. The measured values were used to determine associations with SSI occurrence. This study was approved by the local ethics committee (registration number: 05/15/2020-2020.05.1.05.037).

Patients who underwent surgery at one or two levels by the microdiscectomy procedure were included in the study. Patients with a spinal fracture, infection and tumour, spondylolisthesis, deformity and previous spinal surgery were not included in the study.

Incisional SSI is classified as superficial (from the skin to the lumbodorsal fascia) or deep (lumbodorsal fascia and below). We classified our patients as those with superficial or deep wound infection. The representative cases for superficial and deep infections are presented in Figures 1 and 2, respectively.

The results were compared with those of 80 women and 80 men, selected randomly from a pool of patients who were operated in the same date range and with the same surgical approach, but did not develop SSI. All the patients received a single dose of antibiotic prophylaxis intravenously 30 minutes before the surgery. In all surgeries, the same protocol was used for the preparation of the surgical area.

In the follow-up, patients with wound problems that required antimicrobial treatment were re-hospitalised. Each patient was questioned and investigated for localised pain, erythema, oedema, incision dehiscence, purulent drainage from the incision and fever >38 °C. The last magnetic resonance imaging (MRI) examination of the patients shortly before the lumbar disc surgery was obtained, and a new MRI was performed when hospitalised for the SSI. Tissue samples submitted for culture that were obtained by wound swap, needle aspiration or the open surgery method were recorded.

The BMI classification was used with its definitions follows: BMI: 18.5–24.9 kg/m^2 (normal), 25.0–29.9 kg/m^2 (pre-Obesity), 30.0–34.9 kg/m^2 (Obesity class I), 35.0–39.9 kg/m^2 (Obesity class II) and above 40 kg/m^2 (Obesity class III) in adults. BSA was calculated and expressed in m$^{2(20)}$.

The data from lumbar MRI scans belonging to the patients and saved in Digital Imaging and Communications in Medicine (DICOM) format were obtained with a software provided by DICOM company. SFT and DLS for each patient were measured on the axial and/or sagittal T1-weighted image (presented in Figure 3). The measurement was made by two independent observers, and the average of the results was considered.

Statistical Analysis

Nominal data are presented as percentages while numerical data are presented as average and standard deviation. Comparison between groups was done using the chi-square and Fisher's exact test depending on the number of group subjects for nominal data, Kruskal-Wallis and Mann-Whitney U tests for

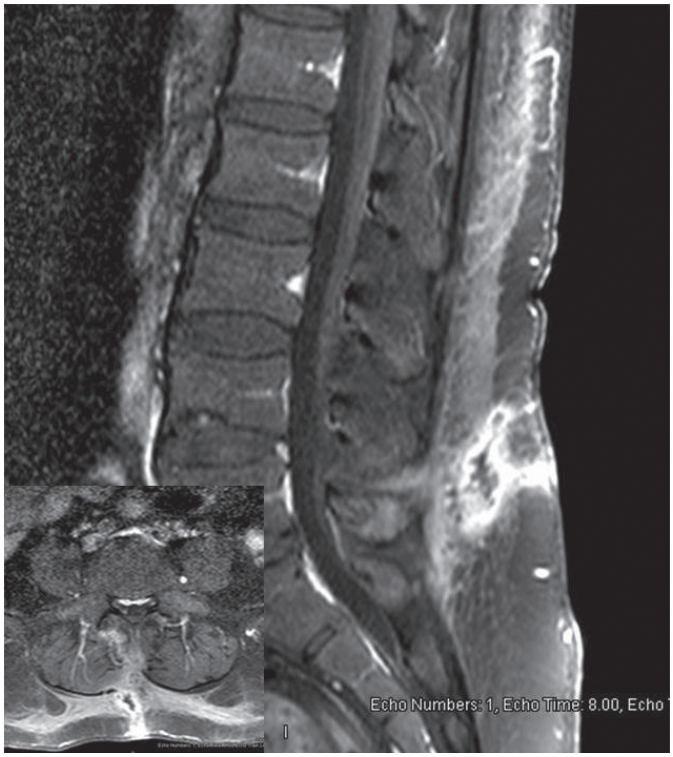

Figure 1. The figure shows a superficial SSI in the T1-weighted contrast MRI of a patient who underwent L5-S1 discectomy
SSI: Surgical site infection, MRI: Magnetic resonance imaging

Figure 2. The figure shows a deep SSI in the T1-weighted contrast MRI of a patient who underwent L4–5 discectomy
SSI: Surgical site infection, MRI: Magnetic resonance imaging

sequential data and variance analysis and t-test for numerical data. Bonferroni correction was used when variance analysis was done. P<0.05 was considered significant. Professional help was obtained for the statistical calculations.

RESULTS

SSI was detected in 32 patients (2.5%) after the LDH surgery. Characteristics of the study population and comorbidities are presented in Table 1.

The most common complaint at re-admission was low back pain and temperature increase in the incision line and the most common finding was severe low back pain with percussion and wound dehiscence. In the 32 patients who developed SSI, 36 levels of lumbar disc surgery were performed (four surgeries were performed at two levels). The most frequent level was L4–5 (22 cases, 61.2%), followed by L4–5 (10 cases, 27.8%), L2–3 (2 cases, 5.5%) and L2–3 level (2 cases, 5.5%). The superficial SSI was encountered in 71.9% of patients (11 women vs 12 men) and deep in 28.1% (4 women vs 5 men).

We evaluated whether the BMI, BSA, SFT and DLS had any effect on SSI occurrence (presented in Table 2). In the SSI group, 33.3% of the women were pre-obese, 67.7% were obese, and this rate was 64.8% and 35.2% for men, respectively. Comparing the group of men with and without SSI, there was no statistically significant difference in terms of age, comorbidity, SFT, DLS, BMI and BSA (no data provided). When comparing the group of women with and without SSI, there was no statistically significant difference in terms of age, comorbidity, SFT, BMI and BSA (no data provided). When the SSI and non-SSI groups were compared, the DLS value was found to be statistically different in the SSI group (p=0.017) (presented in Table 2). The factor that made the statistical significance was women. Compared to the non-infected group of women with SSI, the DLS value was to be found statistically different in women (p=0.014). Therefore, it is thought that DLS may be a risk factor for SSI occurrence in women.

The bacteria isolation rate was 65.6% (n=21/32). Culture sampling was performed in five patients during debridement. No intervention was conducted because five patients were considered to have no material to be sampled. Gram-positive cocci were responsible for 61.9% of the SSIs, while Gram-negative cocci were responsible for 38.1%. No organism was isolated in five patients (15.6%), three of whom had deep and two had superficial infections. Twenty-one patients were treated with an antibiotic regimen determined by the antibiogram results. The remaining 11 patients were treated with antianaerobic and antiaerobic antibiotics.

Figure 3. The figure shows the measurement of subcutaneous fat tissue (blue arrow) and distance of the lamina-to-skin (red arrow) on the T1-weighted MRI along the surgical route
MRI: Magnetic resonance imaging

Table 1. The table shows the age, sex and comorbidities of the patients included in the study

	Patients in the control group (n=160)	Patients in the SSI group (n=32)	p
Age, mean (± SD), year	50.5 (±12.4)	48.3 (±11.9)	0.747
Diabetes	30	9	0.229
Hypertension	45	9	0.577
IHD	9	4	0.237
COPD	11	1	0.694
RA	7	2	0.647
Comorbidities (total)	102	25	-

SSI: Surgical site infection, SD: Standard deviation, IHD: Ischemic heart disease, COPD: Chronic obstructive pulmonary disease, RA: Rheumatoid arthritis, n: Number

Table 2. The table shows the statistical comparisons of BMI, BSA, and radiological measurements of patients with and without SSI

	Patients in the control group (n=160)	Patients in the SSI group (n=32)	p
BMI, mean (± SD), kg/m²	28.8 (±4.83)	30.1 (±4.96)	0.182
BSA, mean (± SD), m²	1.92 (±0.18)	1.94 (±0.03)	0.569
SFT, mean (± SD), mm	27.4 (±11.9)	31.05 (±11.36)	0.110
DLS, mean (± SD), mm	61.73(±13.0)	67.92 (±14.35)	0.017*

SSI: Surgical site infection, SD: Standard deviation, BMI: Body mass index, BSA: Body surface area, SFT: Thickness of subcutaneous fat tissue, DLS: Distances from the lamina to the skin, *Statistically significant (p<0.05), n: Number

The antimicrobial treatment duration of the patients ranged from seven to 37 days. In addition, one of the patients received hyperbaric oxygen therapy as an additional treatment. The average hospital stay for the patients with SSI (range: 4 to 26 days) was 11.5±5.9 days (10.2±4.7 for women and 12.5±6.7 for men).

DISCUSSION

Depending on the technique of the intervention, wound complications occurred at a rate of 2.1% in microdiscectomy, 1.2% in microendoscopic discectomy and 0.5% in the percutaneous discectomy procedure[5]. Golinvaux et al.[4] compared patients who underwent a discectomy in the Spine Patient Outcomes Research Trial (SPORT) study (n=232), a randomised controlled trial, with patients registered in the National Surgical Quality Improvement Program (NSQIP) study (n=6,842). The analysis revealed that the incidence of superficial SSI in the SPORT study was 2% and deep SSI was 0%, whereas in the NSQIP study, it was 0.6% and 0.3%, respectively. Smith et al.[21] analysed 7,213 discectomy patients and found that SSI was present in 0.9%(superficial in 0.5%, deep in 0.4%) of the patients. In the study that used a minimally invasive surgical technique, the SSI occurred in 0.09% of the 4,350 patients (all deep)[3]. In a similar study conducted using the same method with 4,027 patients, the rate of SSI was 0.65% (superficial in 0.42%, deep in 0.23%), and it was concluded that MIST is an independent protective factor against infection[2]. In a systematic review, Zijlmans et al.[22] investigated whether postoperative deep haematoma ranging from 0.15% to 2% was the source of infection, and found no statistical difference in the SSI rate between those who were drained (0.47%) and those who were not (0.88%). The rate of patients with SSI in our single-centre study was 2.5%, which was considerably higher than that in the literature. On the other hand, superficial SSI was detected in 2/3 of the total population in accordance with previous studies.

Numerous studies focusing on the effect of BMI on SSI occurrence after discectomy have been published[4,7,12,13]. In the report comparing the results of the two major studies median BMI was found to be 27.8 kg/m² for SPORT and 29.6 kg/m² for NSQIP, median values of both studies were in the pre-obesity class, and the SSI occurrence rate was less than 2%[4]. In daily hospitalised patients, BMI and SSI were 29.4 kg/m² and 1.13%, respectively[12]. Rihn et al.[13] compared the SSI results in patients with BMI greater and less than 30 kg/m² and found an SSI rate of 2% in both groups. Fakouri et al.[7] evaluated two groups of patients, non-obese and obese, with a median BMI of 24 kg/m² and 38.7 kg/m², respectively. They found that the risk of re-hospitalisation in patients double when the BMI is greater than 40 kg/m². The above-mentioned articles concluded that obesity is not a risk factor for SSI. In our study, the BMI was higher in patients with SSI than in those without SSI, but no statistically significant difference (p=0.182) was found. We concluded that BMI is not a risk factor, which is consistent with the results of previous studies.

A study reported that the BMI result does not accurately reflect the regional adipose tissue[15]. It is also unable to distinguish between fat and lean mass, whereas the body composition consists of fat, muscles, bones, water and other tissues. Therefore, researchers attempted to obtain a new parameter to estimate SSI by measuring regional subcutaneous tissue[16-19]. Mehta et al.[16] examined the SFT and DLS by taking measurements at the L4 level in 28 cases who underwent fusion surgery. They found higher SFT (p=0.035) and DLS values (p=0.046) in infected patients than in healthy subjects and concluded that SFT is more valuable in predicting SSI than BMI. Li et al.[18] studied the SFT in 20 patients with transforaminal lumbar interbody fusion (measured at the same level) and concluded that ıt is an independent risk factor for SSI occurrence (p=0.001). Lee et al.[17] evaluated subcutaneous adipose tissue with multi-level measurements from T12 to L5. They found that each mm of SFT increase leads to a 6% increase in SSI rate, and if the thickness is above 5 cm, it leads to a 4-fold increase, which supports the finding that SFT has a statistically stronger effect compared to BMI. Peng et al.[19] found that there was a significant increase in the SSI rate when the fat tissue thickness exceeded 4 cm in patients who underwent spinal surgery (performed multi-level measurements). The route through which surgery was performed was assessed in the study. When comparing the SSI and non-SSI groups, a statistically significant difference

was found in the DLS measurement results in favour of the SSI group (p=0.017). After applying additional statistical test, we found that the difference was due to the high DLS values in women (p=0.008). In our study, it was concluded that the length of the surgical path rather than the SFT thickness is an important factor in the occurrence of SSI in women. Our results were similar to those of patients who had undergone a major spinal surgery.

BSA is often used to calculate the doses of treatment agents. Recently, studies have been conducted to link BSA to body weight and obesity[23,24]. In obesity, a disproportionate increase in BSA occurs in patients with different weights as the height remains constant. Even though BSA can be calculated using different methods[20,23,24], its results have generally been shown to deviate significantly from the bodyweight curve[20]. In our study, BSA has the weakest statistical result (p=0.569) among the four measurements examined. We believe that it is not appropriate to be used in such studies.

CONCLUSION

To our knowledge, the present study is the first in the literature that investigated the relationship between SSI, SFT and DLS in patients who underwent LDH surgery. Our study revealed that the DLS could be used to predict the risk of SSI occurrence in female patients.

Ethics

Ethics Committee Approval: This study was approved by the Ethics Committee of University of Health Sciences Turkey, Bağcılar Training and Research Hospital (registration number: 05/15/2020-2020.05.1.05.037).

Informed Consent: Retrospective study.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: İ.G., F.K.G., Concept: İ.G., F.K.G., Design: İ.G., F.K.G., Data Collection or Processing: İ.G., Analysis or Interpretation: İ.G., F.K.G., Literature Search: İ.G., F.K.G., Writing: İ.G.

Conflict of Interest: No conflict of interest was declared by the authors.

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