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ORIGINAL ARTICLE

The role of poor oral health in surgical site infection following elective spinal surgery

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Abstract

Study design Cross-sectional study.

Objectives To describe oral health and hygiene as a risk factor for surgical site infection (SSI).

Methods This cross-sectional study was conducted on patients over 18 years of age who were candidates for elective spinal surgery. The exclusion criteria were immunodeficiency, history of cancer, history of previous infection at the surgical site, cutaneous diseases and long-term use of corticosteroids. Questionnaires were filled out for patients via an interview in order to collect the demographic data of patients. Oral and dental examinations were performed using DMFT (D: decayed, M: missing, F: filled, T: total) and PUFA (P: pulp, U: ulcer, F: fistula, A: abscess) indices. Data were analyzed using Fisher's exact test and Mann–Whitney test.

Results A total of 78 patients were evaluated. There were 59 females (75.6%) and 19 males (24.6%). Eight patients were positive for SSI. Teeth caries ($P=0.016$) and periodontal disease ($P=0.049$) were significantly correlated with SSI. No significant association was noted between PUFA and SSI ($P>0.05$). Sixty-five patients (83.3%) had a history of dental infection before surgery. Fifty% of patients being positive for SSI had a history of dental abscess ($P=0.023$).

Conclusions A significant association exists between SSI and caries, gingivitis/periodontitis and history of dental abscess.

Keywords Surgical wound infection · Spine · Surgical procedures, operative · Oral hygiene, tooth caries

Introduction

Surgical site infection (SSI) is the most common hospital-acquired infection occurring postoperatively [1]. Despite antibiotic prophylaxis, improved surgical techniques and postoperative care, postsurgical infections still occur [1]. In the USA, SSI is the most common hospital-acquired infection [2]. According to Chahoud et al. [3], SSI following elective spinal surgery increases the patient cost by $4067.

The prevalence of SSI range is from 0.7 to 16% [1]. Risk factors for SSI can be divided into two groups: patient-related and surgery-related risk factors [1]. Patient-related risk factors include age over 70 years [1, 4], diabetes mellitus, obesity, smoking [1, 3–5], use of steroids, alcohol consumption [3, 4], cardiovascular diseases, chronic obstructive pulmonary disease [1, 4] and malnutrition [4]. Important surgery-related risk factors include bleeding during surgery [1], posterior approach, prolonged surgery and using of devices (instrumentation) [1, 6].

Staphylococcus aureus (*S. aureus*) is the most common microorganism causing SSI [1, 3, 7]. Other germs in

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decreasing scale are *Staphylococcus epidermidis* [1, 3] and *Enterococcus faecalis* [1, 7]. Gram-positive bacteria play a major role in occurrence of SSI [1, 3, 7]. In some studies, methicillin-resistant *S. aureus* has been reported as the most common cause of hospital-acquired infections [4, 7].

Over six billion microorganisms are present in the oral microflora. Most oral pathogens are Gram-positive anaerobes [8]. Since some pathogens responsible for development of SSI are present in the oral environment, SSI and oral and dental infections may be correlated. This association has been confirmed for infections following arthroplasty and hip and knee prosthesis and oral and dental infections, and antibiotic prophylaxis prior to dental treatments has been suggested for these patients [9–13]. Bacteremia may occur following tooth extraction, scaling, periodontal probing, suture removal, orthodontic treatment and restorative and root canal treatments. Also, bacteremia may occur following routine daily functions such as chewing, tooth brushing and dental flossing [8]. Bacteremia occurring following mastication is eliminated by the host defense mechanisms within 10 min [14]. However, this elimination only occurs when the immune system is working properly and the patient has favorable oral hygiene. Periodontal patients have higher risk of bacteremia than those with healthy periodontium [8].

In general, the whole body surface that has normal microflora and bacteremia occurs following incision of these surfaces such as skin, gastrointestinal mucosa, genital mucosa, respiratory mucosa and oral mucosa [5]. It has been documented that patients with a history of joint replacement must undergo antibiotic prophylaxis prior to invasive oral and dental procedures [8, 9, 15]. Also, patients who are candidates for hip and knee surgery must undergo a thorough oral and dental examination by a dentist prior to surgery. However, adequate evidence does not exist to support the association of SSI following spinal surgery and oral infections.

Candidates of spinal surgery are at risk of developing SSI risk of infection especially in patients undergoing posterior approach and instrumentation. Infection has negative impacts on the general and psychological status of patients, as well as, has a negative impact on health system. Also, it may necessitate a frequent surgical procedure for debridement increasing the hospital stay and cost. It delays the course of recovery as well. Since oral cavity has a diverse microflora, it may have associations with SSI, also, because of existing enough evidence supporting positive correlation of oral infection and periprosthetic joint infection in total joint arthroplasty, and lack of evidence regarding this correlation in spine surgery, this study has been designed to answer this question whether poor oral hygiene might cause postoperative infection following elective spine surgery.

Materials and methods

This cross-sectional study was conducted in the Orthopedics Department of Imam Khomeini Complex Hospital from September 2015 to September 2016. The study protocol was approved in the ethics committee of Tehran University of Medical Sciences. All participants were signed informed consent forms and aware of the study protocol.

The inclusion criteria were all patients over 18 years of age who were candidates for elective spinal surgery. The exclusion criteria comprised immunodeficiency, history of cancer, history of previous infection at the surgical site, skin disease and long-term use of corticosteroids.

Data were collected via an interview, clinical examination, questionnaire and assessment of radiographs.

Demographic information of patients including age, sex, BMI, history of previous spine surgery, smoking, diabetes mellitus, systemic diseases and drug use was collected according to the interview and questionnaire. Also, type of surgical procedure and the need for instrumentation were determined by the spine surgeon.

Complete oral and dental examination was done by the dentist for all patients. Comprehensive history of dental infections in the recent years such as abscess or cellulitis and oral hygiene measures (tooth brushing, dental floss, mouth rinse or all three), was taken. Two reliable indices: DMFT (D: decayed, M: missing, F: filled, T: total) and PUFA (P: pulp, U: ulcer, F: fistula, A: abscess) were used in oral examination.

Oral and dental examinations were performed using an explorer and a dental mirror under head light. Also, active periodontal diseases such as gingivitis, tooth mobility and gingival recession were recorded.

According to the routine protocol of our department, the following was done:

1. Patients took a shower the night before surgery
2. Shaving of the surgical site in the operating room by electric clipper
3. Antibiotic prophylaxis by injection of 1 or 2 g of cefazolin (based on the patient's weight) 20 min prior to the operation; in case of allergy, 600 mg clindamycin or 1 gr vancomycin were administered intravenously.
4. Antibiotic was repeated 3 h after initiation of surgical procedure or in case of bleeding more than 1000 cc during surgery.
5. Vacuum drain was inserted after the surgery

Routine follow-ups were scheduled at 2, 6 and 12 weeks, 6 months and 1 year after the surgery. The wound status, physical conditions of the patient, fever, night sweats, systemic signs/symptoms and medications taken were all

Table 1 Relationship of periodontal disease (PD) with surgical site infection

	Negative PD	Positive PD
Negative SSI	39 (55.7%)	31 (44.3%)
Positive SSI	2 (25.0%)	6 (75.0%)

Table 2 Relationship of history of oral infection (OI) with surgical site infection

	Negative OI	Positive OI
Negative SSI	61 (87.1%)	9 (12.9%)
Positive SSI	4 (50.0%)	4 (50.0%)

evaluated in each follow-up session. The surgeon evaluated the patients based on the center for disease control (CDC) definition of SSI and assigned each patient to SSI-positive or SSI-negative group. According to the CDC classification, SSI is divided into three groups of superficial, deep and organ involvement. The superficial type refers to the local infection of the skin and underlying tissue. The deep type refers to the infection of the fascia and causes disk inflammation, epidural abscess and spondylitis.

Also, the patient underwent oral and dental examinations again after surgery, and any change in their oral/dental conditions was recorded.

The data were analyzed using Fisher's exact test for periodontal disease and history of oral infection, and Mann–Whitney test for caries, oral hygiene, DMFT and PUFA. SPSS version 22 was used for statistical analyses at $P < 0.05$ level of significance.

Results

A total of 78 patients who were candidates for spinal cord surgery were evaluated. There were 59 females (75.6%) and 19 males (24.6%). The mean age of patients was 57.17 ± 6 years and the mean BMI was 27.6 ± 2.3.

Seventy patients were SSI negative, and eight patients were positive. All infections were deep, and all patients who developed deep infection within 3 months of index surgery were entered in this study; no death was occurred among the study group. In this study, 50% of SSI-positive patients had dental infection and 12.9% had a history of infection in the negative group. On the other hand, the frequency of generalized periodontitis was 44% in the positive group, which was significantly higher than the negative group ($P = 0.049$) (Table 1). Seventy patients were negative and eight were positive for SSI. No significant association was noted between PUFA and SSI ($P > 0.05$). A total of 65 patients (83.3%) had a history of previous oral infection. In SSI-positive patients, four out of eight patients had a history of dental abscess ($P = 0.023$, (Table 2). Also, a significant association was noted between SSI and caries ($P = 0.016$, Table 3).

In terms of type of surgical procedure, laminectomy was the most commonly performed and laminectomy with PSF and with discectomy was the least commonly performed surgical procedure. The most common diagnosis was spinal stenosis. In general, 94.9% of surgical procedures were performed in the lumbar and 5.1% were performed in the cervical area; instrumentation was applied in 49 patients. Table 4 summarizes the prevalence of surgical site infection related to general risk factors.

Table 3 Mean DMFT score of caries in patients with and without surgical site infection

SSI	Minimum	Maximum	Mean	SD	Number of patients
Positive	0	8	4.14	2.58	8
Negative	0	8	1.87	2.13	70

Table 4 Prevalence of surgical site infection (SSI) related to general risk factors in our study group

Risk factor	SSI
Diabetes	7.7% (6)
Smoking	15.4% (12)
History of dental infection	16.7% (13)
Instrumented spinal fusion	41.0% (32)
History of past spine surgery	6.4% (5)
Periodontal problem	47.4% (37)
History of drug use	10.3% (8)

Discussion

Surgical site infection is the most common hospital-acquired infection occurring postoperatively [1]. The prevalence of SSI varies from 0.7 to 16% [1]. Maderazo et al. [16] stated that oral bacteria can cause delayed prosthetic joint infection in up to 15% of patients. Staphylococcus aureus is the most common microorganism causing SSI [1, 3, 7], which is a Gram-positive coccus. Gram-positive oral bacteria play a role in occurrence of diseases. Common risk factors for SSI include old age, history of previous infection, smoking, diabetes mellitus [17], cardiovascular diseases, chronic obstructive pulmonary disease [1, 4] and malnutrition [4]. Some studies have shown that *Streptococcus viridans*, which is a common oral bacterium, can play a role in delayed prosthetic

joint infection [12, 18]. *Streptococcus mutans* is the most common cariogenic microorganism. Waldman et al. stated that this microorganism can also play a role in prosthetic joint infections [12]. The PUFA is a clinical index which represents oral and dental manifestations due to the lack of treatment for oral infections. The origin of these infections may be related to periodontal and periapical tissues, and according to our results, it seems that dental infection plays a more important role in periodontal infection in postsurgical spine infections. In the current study, we found a significant association between SSI and dental caries. In our study, there was no significant relation between SSI and DMFT index; however, teeth caries had a significant relation which can show active teeth caries has a special role for SSI. On the other hand, no relation with oral hygiene and role of the teeth caries could show the importance effect of another risk factor too.

Dental abscess is an infection, which is manifested by pus formation around teeth in alveolar bone, and often occurs secondary to dental caries, trauma, deep caries or unsuccessful root canal therapy [19]. Microorganisms that cause dental abscess include *Streptococcus viridans*, *Streptococcus anginosus*, *Prevotella intermedia*, *Fusobacterium nucleatum* and anaerobic cocci [20].

The most common bacteria involved in development of SSI are Gram-positive cocci, and our study also showed a significant association between dental abscess and SSI.

Since the main objective of this study was to assess the correlation of SSI and oral health, sample size was calculated to determine that this correlation and other risk factors such as diabetes mellitus and smoking were excluded and their correlation with SSI was not evaluated. Also, many other studies have evaluated the correlation of common risk factors with SSI and have reported significant associations. For instance, in 2016, Ojo et al. [21] confirmed the association of diabetes mellitus and SSI.

Case-control design was a strength of this study. Moreover, to our knowledge this study was the first to assess this correlation and no similar study has been conducted.

The limitations of our study were small sample size and not obtaining a culture from the oral cavity prior to surgery. Therefore, designing of a large randomized control trial study to evaluate this issue is needed.

Conclusion

Surgical site infection has been a huge burden on patients and health system. The current study found a significant association between SSI after elective spine surgery and poor oral hygiene. Thus, it is worth to refer these patients to a dentist prior to elective spinal surgery for a complete oral and dental examination. Further studies with larger sample sizes are required to better elucidate such associations.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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