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Risk Factor of Postoperative Lumbar Surgical Site Infection: A Literature Review

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Abstract

Nowadays there have been various advanced techniques to overcome disparate types of lumbar degenerative diseases. However, post-operation complications such as Surgical Site Infection (SSI) still give the surgeon with a big challenge. This article is going to study the risk factor that causes the lumbar SSI by reviewing all the articles that can be assessed through PubMed, websites of science and other internet data base. Numerous articles have stated different reported prevalence rates of 0.7% to 16% for surgical site infection. This article will document the most common and significant risk factors for SSI. At last, we suggest that there should be preoperative patient screening and postoperative internal environment maintenance, this will be the best way to reduce postoperative SSI rate or prevent SSI from happening.

Keywords

Surgical Site Infection (SSI), Post-Operative Lumbar Surgery, Risk Factor, Lumbar Fusion, Review

1. Introduction

Surgical Site Infection (SSI) in spine surgery remains a significant etiology that led to morbidity, increased medical cost, and prolonged hospitalization. Recently, because there has been development of prophylactic antibiotics and advances in surgical technique and postoperative care, wound infection continues to compromise patients' outcome after surgery [1]. This kind of infection places the patient at risk for pseudoarthrosis, adverse neurologic sequelae, chronic pain, deformity and even death. Surgical site infection will prolong the hospitalization and increase the burden to the patient no matter what conservative therapy or re-operative therapy is [2]. This article is going to study the risk fac-

tor that causes the lumbar surgical site infection by reviewing all the articles that can be assessed through PubMed, ZhiWang (China National Knowledge Infrastructure) and other internet data base. The flow diagram of literature analysis is shown in Figure 1, 117 articles were found from the internet data base, 37 articles were excluded without full text access and 80 articles were further extracted for reading. About 50 articles were removed due to not relating to Risk factor or lumbar SSI. Furthermore, 30 articles were fully read, then 18 articles were excluded due to lacking evidence. Finally, 12 articles were fully extracted for the study.

2. Incidence

Numerous articles have stated different reported prevalence rate of 0.7% to 16% for surgical site infection [3]-[8]. Factor affecting SSI can be classified into patient related risk factor and surgical related one. They are uncontrolled diabetes Mellitus, obesity, BMI, smoking, age, malnutrition, immusupressor user and operation duration, degree of operation, and instrument used in surgery, respectively [9]. Previous studies also showed SSI significantly occurring in posterior spine surgery. However, few factors have been associated consistently with increasing the risk of developed spine SSI. Table 1 shows the risk factor correlated to the lumbar SSI with the infection rate 1.5% - 10%, which fulfills the reported prevalence SSI infection rate.

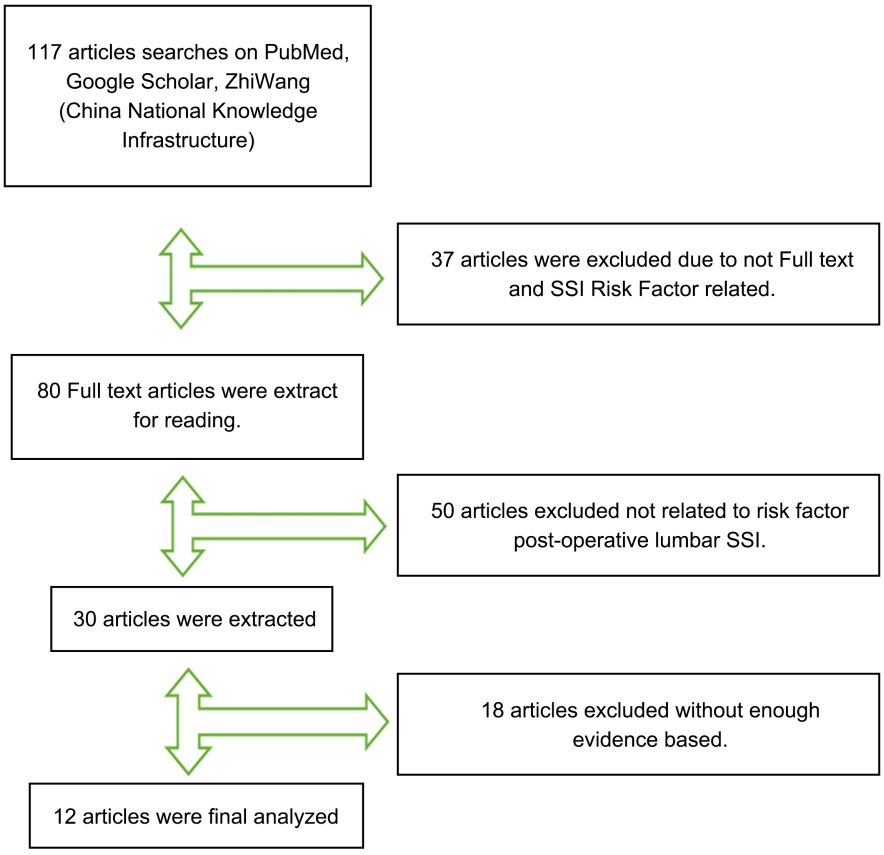

Figure 1. Flow diagram of literature analysis.

Table 1. Risk factor correlated with SSI.

Author	Design	SSI group	Non-SSI group	Finding risk factors/Result	Infection rate (%)
Mehta *et al.*	Retrospective Cohort	24	298	BMI	8.0
Haleem *et al.*	Retrospective Case control	54	2309	Obesity, hypertension	2.3
Klemencsics *et al.*	Prospective Cohort	25/12	723/307	Old ages, BMI	3.5/3.9
Kobayashi *et al.*	Retrospective Case Series	14	384	BMI, mGPS	3.6
Olsen *et al.*	Retrospective Case Control	46	2316	Diabetes	2.0
Peng *et al.*	Retrospective Case Control	37	523	Diabetes, BMI	7.1
Bohl *et al.*	Retrospective Case Series	-	-	Malnutrition, SSI (n = 43,100 RR: 2.3 P = 0.01)	-
Sorensen, L. T.	Review cohort and randomized control trail.	-	-	Smoking, smoker and non smoker were compared in 140 cohort n = 479,150, SSI (OR = 1.79, 95%CI = 1.57 − 2.24); In 4 RCT studies smoking cessation reduce SSI (OR = 0.43 95%CI = 0.21 − 0.85)	-
Kim *et al.*	Retrospective cohort	-	-	Surgical duration more than 5 hours increase the risk of SSI (Table 2)	
Rechtine, G *et al.*	Retrospective Case Series	12	117	Trauma	10.0
Ranson *et al.*	Retrospective Cohort	-	-	Chronic Steroid user (N = 849 OR = 8.13 P = 0.001)	-
Mueller *et al.*	Retrospective Case series	21	1442	Minimal invasive surgery (MIS) has lower rate of SSI compare to open surgery. Total SSI is 21, MIS 5, Open 16, P = 0.002	1.5

Table 2. Correlation of the surgical duration with SSI (Kim *et al.*, 2014).

Operative Duration (hr)	Superficial SSI			Organ/Space SSI		
	OR	95% CI	P	OR	95% CI	P
<2		Ref			Ref	
2 - 2.99	2.6	0.96 - 7.38	0.061	2.11	0.22 - 20.49	0.518
3 - 3.99	3.85	1.40 - 10.59	0.009*	1.75	0.16 - 19.53	0.648
4 - 4.99	4.39	1.50 - 12.88	0.007*	6.35	0.70 - 57.89	0.101
≥5	3.97	1.38 - 11.46	0.011*	9.72	1.18 - 80.22	0.035*

3. Diagnosis

Definition of surgical site infection is based on the national health care system, superficial or acute surgical site infection which occurs within 30 days after an operative procedure and involves only skin and subcutaneous tissue of the incision with redness and swelling. Deep or late surgical site infection occurs more

than 30 days after an operative procedure and involves deep soft tissues of the incision fascial and muscle layers [10].

Early diagnosis of surgical site infection can improve the prognosis. Routine blood test with White blood cell count, Lymphocyte, Heparin-binding protein (HBP), Procalcitonin (PCT), C-reactive protein (CRP), ESR combining with imaging technic Magnetic Resonance Imaging (MRI) can increase the accurate diagnosis. MRI due to its sensitivities, early inflammation can be easily seen on the image with hyperintensity [11] [12]. PCT and CRP have more sensitive and reliable peak than ESR while there is an inflammation [13]. CRP has a shorter period of peak than ESR [14] [15] [16] [17]. Another lab diagnosis tool was Heparin Binding Protein (HBP) also called as azurocidin. Many studies showed that it has the better accurate result of detecting infection compared to others shown above. Wu *et al.* showed that HBP had the best discriminative capacity to distinguish from sepsis than other systemic inflammations [18]. Linder, A *et al.* figured out that HBP can be used in detecting early bacterial meningitis [19]. According to the above, we know that HBP can also help in early diagnosis of acute SSI, due to HBP deriving from neutrophile protein, it acts as an inflammation amplifier which causes capillaries leakages when the inflammation takes place [20].

4. Risk Factors

4.1 Patient-Related Factors

1) Body Mass Index (BMI) is a reliable indicator of body fatness for most people. Many articles showed that BMI and SSI have close relationship, Mehta reported that Obesity (BMI ≥ 30) causes SSI (P = 0.025) among 298 patients, which is statistically significant [21]. Meta-analysis of Zhang, L.*et al.* showed the pool estimate suggested that patients with high BMI values had a higher risk of developing SSI (WMD 1.32 kg/m^2, 95% CI 0.39 - 2.25; P = 0.006) [22]. Combining with previous studies, the correlation with increasing BMI and SSI, when BMI is increased by 5 kg/m^2, the risk of postoperative SSI is accordingly increased by 10%. We can ensure that obese patient has higher incident rate of SSI than non-obese patient, fat layer under the incision sites will lead to late healing due to fat liquefaction, this will be the one of the independent risk factors for SSI [23] [24] [25] [26]. Therefore, patient selection will be a key for elective interventions, and appropriate infrastructure aids in the ultimate outcomes for both elective and nonelective surgical treatments to minimize SSI happened [27].

2) Diabetes Mellitus is an independent risk factor of SSI. Olsen found that either preoperative blood glucose > 125 mg/dL or postoperative blood glucose >200 mg/dL are in-dependent risk factors for SSI [odds ratio 3.5 (P = 0.004) [28]. Hwang, J. U. team discovered that hb1c level more than 6.9% would increase the risk of getting SSI [29]. Peng, W. concluded that during 6 years of retrospective study of 523 Diabetes Mellitus patient who went for lumbar surgery, 7.1% got SSI, superficial infection accounted for 4.2% and deep infection made up 2.9%

[30]. So preoperative blood glucose level, hb1c level control is strictly required for prevention SSI.

3) Elderly patients. Many scholars have confirmed that older patients are a crucial risk factor for postoperative incision infection. Studies have shown that age older than 60 is a risk factor for SSI after spinal surgery. The reason why elderly patients are prone to incision infection is considered to be related to the relative decline of surgical tolerance and tissue repair ability in this group of people. A study by Kanafani *et al.* found that among patients undergoing spinal surgery, the average age of postoperative incision infection was 59 years of age, the mean age with no onset infected patients was 47 years old. This also demonstrates that advanced age is an important risk factor for postoperative incision infection after spinal surgery [31].

4) Smoking can be confirmed as a risk factor for surgical site infection in any types of surgery. Sorensen, L. T. conducted a systemic review and found that smoker had a higher risk to get healing complication after surgery than non-smoker and also smoking cessation intervention could reduce surgical site infection [32]. Pei, H. and their teams conducted case-control studies, finding that for former smoker cessation smoking 6 - 8 weeks before surgery the complication rate had significantly reduced in intervention group compared to control [33]. In this situation, preoperative management for smokers to stop cigarette will be an alternative way to reduce risk of SSI.

4.2. Surgical-Related Risk Factors

1) Operation duration. Kim *et al.* in a multicenter retrospective cohort study showed that increasing the duration of operation time was associated widely with increasing the risk of getting infection and other complications [34]. Meredith reviewed a consecutive series of 3218 patients concluded that incidence rate of getting SSI was 2.6% with the risk factor longer the duration of surgery [35]. It is believed that minimizing the surgery duration and strictly obeying the operation guideline will bring lower infection rate to the patient. In addition, antibiotic medication should be given during operation and post-surgery if the operation time exceeds more than 3 hours and extends for another 2 days after surgery can significantly minimize the risk of getting SSI from 7% to 3.6% stated in Meredith's review.

2) Type of surgery is a procedure or a method that is used to treat or remove the pathology from the lumbar site. Recently, there have been many types of minimal invasive method to overcome degenerative lumbar illness, such as MIS-TLIF, Endo-LIF, UBE, LLIF and so on [36] for open procedures such as TLIF, PLIF. As we know that minimal invasive technique has the lower outcome of SSI compared to routine technique. That might be due to less blood loss during the operation, less surgical area contacted with the open atmosphere [37]. This brings the patient with better prognosis and shorthorns the hospital stays [38].

3) Level of fusion and blood loss prior to the surgery. Previous studies had already noted that blood loss was correlated with level of intervertebral body fusion, as the incision getting larger the blood will loss more during the operation. This leads to risk of SSI happen. Hollern *et al.* presented that number level of spinal fused was an independent predictor in patient with postoperative surgical site infection [39]. Other than that, epidural tear is also one of the risk factors to get SSI involved. CSF leakage slows down the wound healing and keeps the surgical area exudate, this provides a condition for micro-bacteria accumulation, thus increases the risk of SSI [40] [41].

4.3. Other Relative Factors

1) Malnutrition: Many researchers found that pre-operative and post-operative malnutrition or with low serum albumin patient had higher chance to get involve in SSI. Yamamoto *et al.* carried out multicenter retrospective studies and showed that malnutrition was an independent risk factor for infection and other complications and increased the length of hospital stay [42]. Malnutrition indicate serum albumin concentration level lower than 3.5 g/dL. Malnutrition is a potentially modifiable risk factor that may contribute to complications following spinal surgery [43]. In retrospective study of Phan, K *et al.* also concluded that a poor preoperative nutrition status had been suggested to be a risk factor for postoperative complications in adults undergoing surgery [44]. Therefore, surgeon was suggested to do preoperative nutrient screening for all the patients who were undergoing elective surgery.

2) Traumatic spine injury or neoplasm population: In numerous articles well documented traumatic spine injury population the SSI rate is significantly higher, especially those with neurologic injury. Rechtine *et al.* conducted case series studies and concluded that trauma patient with instrument lumbar fixation after surgery had a higher risk of SSI compared to those with elective lumbar surgery, population with complete neuro defy had greater risk [45]. As we know that trauma state or injury state or even tumor patient, body metabolism rate will increase, this will lead to increase minor element consumption such as amino acid and other factors, therefore results in nutrient deficiency. As we know malnutrition is an independent risk factor for SSI. On the other hand, trauma might cause open injury, this increases the chance for pathogen deposited in the body.

3) Prolong bed rest after surgery: From our clinical experience, it is known that patients with long term on bed will always face the wound healing problem. Firstly, long time keeping the same position on bed will cause ischemia around surgical wound due to poor blood perfusion. Secondly, patients living on bed face problem with incision site easily contaminated with urine and feces. Therefore, this might be a risk factor for SSI especial for elderly people with commodities. Recently, many scholars have conducted Enhance Recovering After Surgery (ERAS) studies, significantly showing that the result decreases in the length of hospital stay and related complication. A retrospective study of d'Astorg *et al.*

showed no significant difference between BMI, smokers, old ages, DM patients in ERAS program [46]. So, patients are encouraged for earlier ambulation.

4) Long term steroid user: A retrospective analysis result of Singla *et al.* showed that chronic intake of steroid was associated with significantly increased risk of 1-year mortality and considerably increased risk of SSI at 90 days [47]. Another scholar—Ranson, W. A. *et al.* from his retrospective cohort study showed that chronic steroid usage would bring severe postoperative site effect, most significantly increased twice of the risk of surgical site complication rate [48].

5. Prevention and Treatment

As the infection is firstly discovered, we should start or extend anti-infectious therapy at the first point. Tsubouchi, N *et al.* from his review studies showed that the delay in administering effective antibiotic was an independent risk factor for implant removal in posterior spine surgery [49]. Following with that if the surgical site got worse or from MRI could found inflammation exudate formed, re-operation for debridement had to be carried out to eliminate or stop infection widespread. Some articles showed that continuous drainage for the wound or vacuum suction was the best technic for SSI treatment [50] [51] [52]. Many researchers stated that debridement with a course of anti-infection therapy was a standard care for SSI, the prognosis was well-defined [53]. Recently minimum invasive debridement technic also has been introduced by Yang, S. C.in his protocol percutaneous endoscopic debridement technic, which has shown the effectiveness with successful rate of 65% with low complication compared to open debridement [54]. This method could be an alternative way for certain deep infection patients, it is a minimum invasive surgery compared to traditional way and elderly patient can be tolerant for second operation. On the other hand, some patients suspected with high risk of SSI, local use of vancomycin before closure of the wound will have a better outcome after surgery [55]. From the retrospective study of Tomov, M. *et al.*, it was shown that intraoperation used of local vancomycin and betadine irrigation has significantly reduced by 50% of the risk of SSI after lumbar fusion surgery [56]. So far, there have been still many controversies about the treatment of postoperative infection of lumbar spine. Kobayashi, K *et al.* in multicenter retrospective study concluded that early debridement after SSI diagnosis might have contributed to instrument retention [57]. To this day, early diagnosis with appropriate management of SSI has better prognosis.

6. Conclusion

As the risk factor documented in this article is the most common and significant risk factor for SSI, therefore, preoperative screening patient condition and postoperative internal environment maintenance will be the best way to reduce postoperative SSI rate or prevent SSI from happening. Furthermore, for a

surgeon, it is better to review the patient's condition then carry out with corresponding surgical procedure as this can effectively minimize the rate of SSI. Last but not least, early detection of SSI with the appropriate treatment can relatively reduce the cost and length of hospital stay. Preoperative selection and preparation for elective patient who went for lumbar surgery can significantly reduce the rate of SSI.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations

SSI: Surgical Site Infection
BMI: Body Mass Index
HBP: Heparin-binding protein,
PCT: Procalcitonin Test
CRP: C-reactive protein
ESR: Erythrocyte Sedimentation Rate
MRI: Magnetic Resonance Imaging
WMD: Weighted Mean difference
DM: Diabetes Mellitus
ERAS: Enhance Recovering After Surgery
MIS-TLIF: Minimal Invasive Surgery-Transforaminal Lumbar Interbody Fusion,
Endo-LIF: full-endoscopic translaminar lumbar interbody fusion
UBE: Unilateral bi-portal Endoscopic technique