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Risk factors for surgical site infection after instrumented fixation in spine trauma

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Abstract

Surgical site infection (SSI) represents a significant complication after instrumented fixation in spine changes have emphasized early fracture correction, shortened intraoperative times, early ambulation, and prompt nutritional supplementation. This retrospective study evaluates the senior author's experience of instrumented spinal trauma SSI occurring at a single Level I trauma center over two equal and contiguous time periods, 2005–2007 (before nutritional supplementation was added to the institutional protocol) and 2008–2010 (after nutritional supplementation was added). This study assessed whether SSI varied depending on the primary surgical site and/or by the chosen approach. Lastly, the incidence of SSI among demographic and other clinical variables was evaluated. In total, 358 patients underwent an index procedure for spinal trauma correction. Fourteen patients developed a SSI requiring reoperation for an incidence of 4.0%.

In assessing nutritional supplementation, the probability of infection tended to be lower in the supplemented group (3.7%) than the pre-supplement group (4.3%), but this did not reach significance. The difference in approach for the cervical spine was statistically significant ($p = 0.045$) with rates of infection via posterior approach at 8.1% and no infections via anterior approach. Presence of comorbidities ($p = 0.03$) and time to surgery >3 days ($p = 0.006$) were predictors of developing SSI. Benefit is shown from early surgical correction of spinal trauma patients in the reduction of postoperative SSI. Nutritional supplementation may provide a small reduction in infections in the spine trauma population.

1. Introduction

Surgical site infection (SSI) occurring after surgical correction of traumatic spine injuries is a relatively infrequent event, but imparts a prolonged postoperative course with increased costs secondary to an increased length of stay, extended use of intravenous antibiotics, and need for further procedures including surgical washout and debridement [1]. Multiple risk

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factors have been identified as predictors of SSI including greater than one liter of intraoperative blood loss, operative time greater than 3 hours, inpatient stay greater than 1 week prior to index operation, and preoperative patient characteristics including smoking, alcohol abuse, malnutrition, diabetes and long-term steroid use [2–5]. The USA National Healthcare Safety Network reported a mean SSI rate of 0.7% to 4.2% for spinal fusions and 0.7% to 2.3% for laminectomies [6]. Rates of infection are generally higher in non-elective instrumented spinal fusions for trauma, with reported rates up to 10% [7]. The increased cost of stay coupled with changes in the Centers for Medicare and Medicaid Services reimbursement practices serve as strong incentives for adopting departmental and hospital policies aimed at reducing the incidence of SSI and improving patient outcomes. This study evaluates the impact of changes in trauma care management of spinal trauma patients on the incidence of SSI and assesses for modifiable risk factors that predispose to the development of SSI.

2. Materials and methods

Prior to implementation of the trauma care protocol in 2008, patients undergoing traumatic spinal fracture correction were given perioperative wound vitamins and standardized wound care on a case-by-case basis. In early 2008, at a multidisciplinary trauma conference, a concerted effort among the neurosurgeons, orthopedic spine surgeons, and trauma service was made to improve the inpatient nutritional status of incoming trauma patients, with prompt supplementation including vitamins, zinc 220 mg daily and vitamin C 500 mg twice daily to promote wound healing. Total protein and albumin levels estimated preoperative nutritional status in this study.

Our institution is the only Level 1 trauma center in the state of Oklahoma and as such sees a high volume of multisystem trauma. In the time period studied, 358 trauma patients had spine injuries necessitating surgical correction. In an effort to evaluate the efficacy of the shift in nutritional supplementation protocol on the incidence of postoperative spine SSI, an Institutional Review Board-approved retrospective review of outcomes in patients 2.5 years before protocol implementation (June 2005 to December 2007) and 3 years after its implementation (January 2008 to December 2010) was carried out. Inclusion criteria were all admitted trauma patients undergoing spinal trauma surgical correction.

Presence of SSI was collected from the senior author’s depart- mental registry of all traumatic spinal fractures undergoing surgical correction during this time period. SSI was defined as deep incisional SSI requiring operative washout and debridement with isolated organisms proven on intraoperative wound culture [8]. All fractures were corrected with placement of instrumentation. The time interval for SSI to occur was defined as up to 1 year post-implantation. An extensive electronic chart review was conducted to identify the variable being studied including the identity of the organism(s) for each wound infection event.

Additional study objectives included comparisons of the incidence of spine SSI among multiple demographic and clinical factors and a comparison of the incidence of spine SSI by surgical site (cervical, thoracic, and lumbar) and by approach (anterior, posterior, and combined anterior-posterior).

2.1. Statistics

Descriptive statistics were created to summarize the distribution of demographic and clinical factors. Chi-squared tests were used to compare the probability of infection between and among groups. Fisher's exact tests were used when more than 20% of expected frequency counts were less than five. Exact trend tests were used when variable categories were ordered. A two-sided 0.05 alpha level was used to define statistical significance. SAS 9.3 was used for all statistical analyses (SAS Institute, Cary, NC, USA).

3. Results

In this study there were 358 index operations with a total of 392 surgeries when including reoperations. Sixty-eight percent of patients were male and only four operations were carried out at the Children's Hospital, with the rest being done at the adult hospital. Neurologic injury of varying severity occurred due to The traumatic event in 46% of the patients studied. Thirty-five percent of patients were placed on mean arterial pressure therapy, while steroids were utilized in only 11% of patients. Also a large percentage (71%) of patients had sustained other injuries due to the trauma. Overall, the percentage of patients developing an infection was very low (14/352 patients, 3.98%, 95% confidence interval: 2.2–6.6%). Data for the full 1 year follow-up period was not available in six patients. Table 1 shows the rate of SSI by time period. Although the probability of infection is somewhat lower following the implementation of the nutritional supplementation protocol (3.7%) compared to the time period without nutritional supplementation (4.29%), this difference is not statistically significant ($p = 0.78$). The site of injury was also evaluated and is listed in Table 2. Although the probability of infection is somewhat higher among patients with lumbar spine injuries (7.87%) compared to patients with cervical spine (2.29%) or thoracic spine (3.03%) injuries, this difference is not statistically significant ($p = 0.090$). The approach was also evaluated for each site of injury (Table 3). Only the posterior approaches include the infection cases for all three of the preoperative diagnosis sites. For the cervical spine, the infection rate with posterior approach (8.1%) is higher than other approaches ($p = 0.0453$). For the lumbar spine, the infection rate is 8% with posterior approach and no infections with other approaches. For the thoracic spine, there is a 3.1% infection rate with posterior approach and no infections with other approaches. Statistical tests were not used for lumbar spine and thoracic spine due to the small sample size of anterior and anterior-posterior approaches.

The incidence of SI was evaluated among multiple demographic and clinical factors (Table 4). The probability of infection is significantly higher among the patients who had history of prior disease ($p = 0.0319$), underwent a posterior approach ($p = 0.0497$) and stayed in the hospital more than 3 days before the surgery ($p = 0.006$). The probability of infection is somewhat higher among the patients who had complications during hospital stay ($p = 0.0612$), had a hospital stay longer than 15 days ($p = 0.0537$), had a preoperative diagnosis of lumbar spine injury ($p = 0.0903$), and had the most recent preoperative serum albumin value 63.8 g/dL ($p = 0.0747$). These differences are not statistically significant. The infection rate does not differ significantly among other demographic and clinical factors.

4. Discussion

In the majority of cases, the bacterial species responsible for the SSI (nine of 14) in this series was methicillin-resistant Staphylococcus aureus (MRSA). Methicillin-sensitive Staphylococcus aureus (MSSA) was the second most common bacteria, being found in three of the 14 cases of infection. Enteric species were the third most common collectively including Enterobacter and Morganella species. In addition, MRSA (n = 4) and MSSA (n = 1) were the culprit bacteria in the five cases which required multiple washouts for persistent infection. MRSA nares swabs for screening on admission were done in six of the 14 patients, and MRSA was detected in one patient. Prior to 2008, intake MRSA surveillance was not routine in all trauma patients. Since 2008, MRSA surveillance has become part of the standard intake protocol on all trauma patients. In the 14 patients with infection, all had received preoperative cefazolin 2 g intravenously except for the patient who screened positive for MRSA on nares swab, who received preoperative vancomycin 1 g intravenously. Interestingly, one patient who developed an MRSA positive SSI on postoperative day 38 also had MRSA positive blood cultures develop on postoperative day 13. Prior studies have reported similar findings of contamination via natural or acquired skin flora, especially in those patients requiring prolonged inpatient stays prior to initial operation. As such, staphylococcus species frequently contribute to the development of SSI [9]. Patients at our center undergo a combination Hibiclens (Mölnlycke Health Care, Norcross, GA, USA) and alcohol wash for skin preparation prior to draping in accordance with Association for Professionals in Infection Control and Epidemiology (APIC) guidelines [10].

As evidenced by the recent focus on placement of intraoperative vancomycin powder into the surgical site, reduction of SSI remains a pervasive concern in how spine surgeons provide operative and perioperative care [11]. The reason for development of SSI is often multifactorial and it was felt that patients with multi-trauma and prolonged intensive care unit stays were at greater risk for development of wound complications including infection. This was supported by our finding that patients who had stayed in the hospital greater than 3 days before the surgery had a higher probability, 8.1% versus 1.7% ($p = 0.006$), of developing a SSI. In addition, those patients who required a hospital stay greater than 15 days also had a higher rate of infection, 7.1% versus 1.8% ($p = 0.053$), though the finding was not statistically significant.

Along the same line, it was felt patients with pre-existing medical comorbidities would experience more surgical site complications, including infection. The presence of hypertension, diabetes mellitus, and/or chronic obstructive pulmonary disease was included in the initial past medical history screening. In patients with prior medical comorbidities there was a higher rate of infection than in those without, 6.9% versus 1.6%, which was statistically significant ($p = 0.032$). No correlation was found between drug, tobacco, or alcohol use and risk of infection nor was the body mass index significant in this study.

In keeping with prior studies, there were no infections in anterior approaches to the cervical spine [12]. When comparing approaches in general, there was a higher incidence of infection in posterior approaches [13]. As a part of the changes undertaken in 2008 to improve trauma care including the reduction of SSI, emphasis was placed on perioperative nutritional supplementation, early postoperative mobilization and appropriate wound care [14]. In our comparison, there was no real difference found between the group prior to 2008 and the group after 2008; rates of infection were 3.7% for the former and 4.3% for the latter. There was, however, a trend toward higher infection rate in those patients with a preoperative serum albumin level less than 3.8 g/dL, 5.5% versus 1.0% ($p = 0.074$), though the finding was not statistically significant. In most cases, physical therapy and progressive mobility was initiated on the first postoperative day depending on whether the appropriate orthosis was in place. In cases with a thoracolumbosacral orthosis, when the patients were recumbent less than 30 degrees, the brace was removed to promote a dry, clean environment for wound healing. Similarly, in cases with a cervicothoracic orthosis, when the patient was recumbent in bed, the vest was removed and replaced with a cervical collar only.

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Table 1

Surgical Site Infection by Time period

	Year of Surgery			
	2005–2007 (without nutritional supplementation)		2008–2010 (with nutritional supplementation)	
Surgical Spine Site Infection	**Count**	**%**	**Count**	**%**
Present	7	4.29	7	3.70
Absent	156	95.71	182	96.30

Table 2

Surgical spine site infection by sites of injury

	Year of Surgery					
	Cervical Spine		Lumbar Spine		Thoracic Spine	
Surgical Spine Site Infection	**Count**	**%**	**Count**	**%**	**Count**	**%**
Present	3	2.29	7	7.87	4	3.03
Absent	128	97.71	82	92.13	128	96.97

Table 3

The probability of infection for surgical approach stratified by preoperative diagnosis sites

	Preoperative diagnosis											
	Cervical spine				Lumbar spine				Thoracic spine			
	Present		Absent		Present		Absent		Present		Absent	
Approach	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Posterior	3	8.1%	34	91.9%	7	8.0%	81	92.0%	4	3.1%	126	96.9%
Anterior	0	0.0%	86	100.0%	.	.	.	.	0	0.0%	1	100.0%
Both anterior and posterior	0	0.0%	8	100.0%	0	0.0%	1	100.0%	0	0.0%	1	100.0%

Table 4

The incidence of spine surgical site infection rate for demographic and clinical factors

	Surgical spine site infection				
	Present (N = 14)		Absent (N = 338)		
Factor	Count	%	Count	%	p value
Patient past medical history					
No history of disease	3	1.6	180	98.4	0.0319
Positive history of disease	9	6.9	121	93.1	
Complications occurring during hospital stay					
No complications	4	2.0	201	98.0	0.0612
Complications present	7	6.1	108	93.9	
Transfusion					
No transfusion	8	3.1	254	96.9	0.1136
At least 1 transfusion	6	7.1	78	92.9	
Sex					
Female	3	2.7	107	97.3	0.5619
Male	11	4.5	231	95.5	
Neurologic injury suffered due to the trauma					
Absent	8	4.5	168	95.5	0.3692
Neurologic injury present	4	2.7	146	97.3	
Tobacco use					
No tobacco use	6	3.2	180	96.8	1.0000
Positive	4	3.7	105	96.3	
Alcohol use					
No alcohol use	5	2.9	166	97.1	0.5382
Positive	6	4.7	122	95.3	
Illicit drug use					
No drug use	8	3.0	258	97.0	0.2805
Positive	2	6.5	29	93.5	
Mean arterial pressure therapy					
Absent	11	5.0	207	95.0	0.1486

	Surgical spine site infection				
	Present (N = 14)		Absent (N = 338)		
Factor	Count	%	Count	%	p value
Present	2	1.7	118	98.3	
Steroids					
Absent	10	3.3	292	96.7	0.1504
Present	3	8.3	33	91.7	
Other traumatic injuries occurred at the time of the trauma					
Absent	1	1.0	96	99.0	0.1856
Present	10	4.3	224	95.7	
Approach					
Anterior	0	0.0	87	100.0	0.0497
Both anterior and posterior	0	0.0	10	100.0	
Posterior	14	5.5	241	94.5	
Preoperative diagnosis					
Cervical spine	3	2.3	128	97.7	0.0903
Lumbar spine	7	7.9	82	92.1	
Thoracic spine	4	3.0	128	97.0	
Number of surgeons scrubbed during the procedure[a]					
≤3	9	4.4	196	95.6	0.7860
>3	5	3.5	138	96.5	
Operative time					
≤90 minutes	6	2.6	223	97.4	0.2062
91–180 minutes	8	7.5	98	92.5	
>180 minutes	0	0.0	11	100.0	
Intensive care unit stay					
≤5 days	4	2.7	145	97.3	0.6594
6–15 days	1	1.3	78	98.7	
>15 days	3	4.8	60	95.2	
Length of stay					
≤5 days	1	2.3	42	97.7	0.0537
6–15 days	3	1.8	166	98.2	

Factor	Surgical spine site infection				
	Present (N = 14)		Absent (N = 338)		
	Count	%	Count	%	p value
>15 days	9	7.1	118	92.9	
Admission to day of surgery					
≤3 days	4	1.7	229	98.3	0.0060
>3 days	9	8.1	102	91.9	
Body mass index					
≤25 kg/m^2	5	4.4	108	95.6	1.0000
>25 kg/m^2	7	3.9	172	96.1	
Age					
≤25 years	1	0.9	109	99.1	0.1078
26–50 years	9	5.4	159	94.6	
51–65 years	2	4.0	48	96.0	
>65 years	2	8.3	22	91.7	
Most recent preoperative serum albumin value					
≤3.8 g/dL	13	5.5	223	94.5	0.0747
>3.8 g/dL	1	1.0	96	99.0	
Serum total protein					
≤6.1 g/dL	4	3.0	131	97.0	0.4166
>6.1 g/dL	10	5.0	189	95.0	
Serum glucose level					
≤111 mg/dL	7	5.0	133	95.0	0.5792
>111 mg/dL	7	3.3	202	96.7	
Serum white blood cell count					
≤11 x 109/L	10	5.5	171	94.5	0.1738
>11 x 109/L	4	2.4	166	97.6	

[a] Including residents and physician