The Incidence of Infection after Posterior Cervical Spine Surgery: A 10 Year Review

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Abstract

Background   The incidence of infection after posterior cervical spine surgery ranges from 0 to 18%. Higher rates have been reported after posterior procedures compared with anterior procedures, but these studies have been for small series. We report on our rate of surgical site infection (SSI) after posterior cervical spine surgery and the risk factors that influence these infections.

Methods   We retrospectively reviewed the records of 90 consecutive patients who underwent posterior cervical spine procedures at a major spinal referral center between 1998 and 2007. The main indications for surgery were trauma and degenerative conditions. Tumors and primary infections were excluded. Medical records of these patients were examined for evidence of SSI as diagnosed by Centers for Disease Control and Prevention criteria.

Results   Using stringent criteria for diagnosing SSI, we found 15 infected patients (16.67%). The postoperative use of a Philadelphia hard collar was found to be a significant risk factor for SSI with a relative risk of 15.30 (95% confidence interval 2.10 to 111.52). Almost half of infected patients (47%) required reoperation for wound debridement, with four requiring skin flap closure. All 15 patients had successful outcomes with complete resolution of their infection.

Conclusions   This study confirms a high incidence of SSI after posterior cervical surgery. The most significant risk factors for SSI were found to be a traumatic etiology and postoperative use of a collar. We believe it is important to develop strategies to minimize the risk of infection after posterior cervical surgery, which include questioning the postoperative use of collars.

Keywords
► cervical vertebrae
► spinal fusion
► surgical site infection
► orthotic devices

Infection is a devastating complication for patients after posterior cervical spine surgery, with consequences ranging from superficial skin infection to advanced osteomyelitis of the spine. Textbooks estimate the incidence of infection to be between 0% and 18%[1]; however, we are not aware of any large series to support these figures, and higher rates have been reported after posterior surgery compared with anterior surgery. In addition, risk analyses for posterior cervical wound infections have usually been extrapolated from posterior lumbar procedures. We decided to review our rates of surgical site infection (SSI) after posterior cervical spine surgery and the risk factors that may influence these.

We were particularly interested in the relationship of postoperative collars and infection rates. In our institution, Philadelphia hard collars have been used regularly by the spinal surgeons to provide additional support in the postoperative period.[2] However, it was thought that the robust nature of their foam-plastic construct may raise the

temperature and humidity of the skin and provide optimal conditions for bacteria growth, therefore increasing the risk of SSI.

Methods

Selection and Description of Participants

We retrospectively reviewed records of consecutive patients who underwent posterior cervical spine operations at a tertiary referral spinal center over 10 years. The patients were treated by six different spinal surgeons. The medical records were examined for evidence of SSI as defined by Centers for Disease Control and Prevention criteria.[3] A diagnosis of SSI was made only if one or more of the following features were present: (1) purulent discharge from the wound, (2) wound infection diagnosed by the treating surgeon, or (3) wound discharge with local signs of inflammation or a positive culture. Postoperative SSIs were diagnosed within 30 days of the index procedure, and strict adherence to the guidelines was maintained.

The main indication for surgery was traumatic fractures and/or dislocations of the cervical spine. Other indications included cervical spine instability and cervical canal stenosis with associated myelopathy. Neoplastic conditions were excluded from the study as it was the authors' opinion that this immunosuppressed group may negatively bias the results. Similarly, primary spinal infections were also excluded.

Several factors have been shown to increase the risk of SSI after spinal surgery, and these were examined as part of the study. These included smoking, diabetes mellitus, American Society of Anesthesiologists (ASA) score >2, use of perioperative corticosteroids, and body mass index (BMI) > 30.[2]

Statistics

The data were organized into a simple 2×2 table, and relative risk (RR) was calculated using the conventional formula $(a/a + c)/(b/b + d)$. RR greater than 1 indicated that infection was more likely in the exposure group (i.e., postoperative patients), and RR less than 1 indicated infection was less likely. 95% confidence intervals were also calculated. Multivariate logistic regression analysis was used to calculate the relative risk of each known risk factor for SSI.

Results

From August 1998 to March 2007, a total of 90 patients were included in the study. Participant characteristics are detailed in ►**Table 1**. Most participants were male and had traumatic etiology requiring emergency surgery. The median age was 44.8 years (range 12 to 85 years), and the mean ASA score was 2.7 (range 1 to 4). Indications for surgery are listed in ►**Table 2**, and a breakdown of operations performed is listed in ►**Table 3**.

Using stringent criteria from Centers of Disease Control and Prevention, we found 15 of the 90 patients to be infected (16.67%), with the mean time between index operation and diagnosis of SSI of 15 days (range 4 to 27 days). The organisms cultured are detailed in ►**Table 4**.

Table 1 Patient Characteristics

Characteristics	n (%)
Sex	
Male	66 (73)
Female	24 (27)
Admission type	
Emergency	66 (73)
Elective	24 (27)
American Society of Anesthesiologists score	
1	8 (9)
2	27 (30)
3	43 (48)
4	12 (13)
5	0 (0)

Table 2 Indications for Posterior Cervical Spine Operations

Indication	n (%)
Traumatic fracture/dislocation	68 (76)
Instability secondary to rheumatoid arthritis	7 (8)
Nonunion of type II dens fracture	6 (6)
Cervical canal stenosis (with myelopathy)	8 (9)
Other	1 (1)

Staphylococcus aureus was present in all positive cultures, with seven patients growing methicillin-sensitive and six growing methicillin-resistant species. Two infected patients had negative cultures, and cultures from three patients grew more than one organism.

Seven patients required at least one reoperation for wound washout and debridement (►**Table 5**). Of these, four went on to require V-Y skin flap closure by the plastic surgeons. There were no reported cases of osteomyelitis and all infections resolved completely. All participants were at least 12 months

Table 3 Type of Operations Performed

Operation	n (%)
Instrumented lateral mass screws (with rods or plate)	64 (71)
Sublaminar wiring (including Brooks and Gallie fusions)	21 (23)
Interspinous wiring (including Dewar)	7 (8)
Transarticular screw (Magerl)	6 (7)
Laminoplasty	3 (3)

Table 4 Organisms Cultured

Organism	*n* (%)
MSSA	7 (47)
MRSA	6 (40)
No organism	2 (13)
Multiple organisms[a]	3

MRSA, Methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *S. aureus*.

[a]MSSA + one of *Escherichia coli*, *Pseudomonas aeruginosa*, or *Acinobacter*.

Table 5 Outcomes for Infected Patients

Outcome	*n* (%)
Reoperation for wound washout and debridement	7 (47)
V-Y skin flap for wound closure	4 (27)
Osteomyelitis of cervical spine	0 (0)
Removal of metal	0 (0)

Table 6 Philadelphia Collars and Infection

	Infection	No Infection	Total
Collar	14	29	43
No collar	1	46	47
Total	15	75	90
Relative risk	15.30		

since their operation, and the last infected patient was 15 months since his operation at the time of writing. Mean follow-up time was 24 months (range 12 to 60 months).

Forty-seven patients (52%) were prescribed Philadelphia collars in the postoperative period. The collars were applied in the operating room immediately after surgery and remained on for at least 48 hours. Eighteen other patients were placed in alternative types of orthotic devices including Minerva braces (4), soft collars (3) and halothoracic vests (11). The remaining 25 patients had no orthotic device postoperatively.

The relationship between Philadelphia collars and infection is summarized in ►**Table 6**. Notably, 14 of the 15 infected patients (93%) wore Philadelphia collars postoperatively. Calculation of the RR suggested that those wearing Philadelphia collars were 15.30 times more likely to develop a SSI when compared with those who did not. The 95% confidence interval (2.10 to 111.52) was significant and confirms at least twice the risk of SSI for any given patient.

Several other factors were examined as part of the study (►**Table 7**). Operation waiting time was defined in emergency cases as the time between injury and surgical intervention, with infected patients waiting 9.4 days longer on average. Mean operating time was significantly higher in the noninfected patients at 187 minutes—almost 1 hour longer than the infected group.

All patients received prophylactic antibiotics at or prior to induction, and these were continued for a minimum of 24 hours postoperatively. The majority of patients (68%) received a single dose of cefazolin (either 1 g or 2 g), 17 patients (19%) received multiple agents, and 12 (13%) received vancomycin as part of their antibiotic prophylaxis. Both vancomycin and multiple antibiotic agents were associated with a decreased risk of SSI with RRs of 0.48 and 0.30, respectively.

Several other factors known to increase the risk of postoperative SSI in spinal surgery were analyzed (►**Table 8**). Smoking (odds ratio 2.10) and perioperative corticosteroids (odds ratio 3.42) showed an increased trend toward SSI after posterior spinal surgery but neither were statistically significant ($p = 0.31$ and 0.42, respectively). A BMI of greater than 30 could not be included in the study as patient height was not recorded in the majority of the medical records.

Discussion

This article confirms a relatively high rate of SSI after posterior surgery of the cervical spine. Furthermore, the use of Philadelphia hard collars in the immediate postoperative period were found to significantly increase infection rates in our group of patients.

Schneider et al[2] reported the results of several contemporary orthoses in reducing the amount of cervical spine movement. Philadelphia collars were found to be effective at the levels C1/2 and C2/3, with only 13.8% and 39.8% of patients able to achieve more than 3 degrees of intervertebral movement, respectively. In contrast, Philadelphia collars were extremely ineffective below the level of C3, and results were comparable to not wearing a collar at all. In our patients who developed a wound infection, all (100%) had their procedures performed at the C3 level or below, and this leads us to question the use of hard collars postoperatively. Extrapolating this information, it would seem that a halothoracic vest is a wiser option if cervical spine stability is a concern. In our study, the use of a collar in the postoperative period

Table 7 Operation Waiting Times and Infection

	Mean	Infected	Noninfected
Operation waiting time (d)	9.4	17.1	7.8
Age (y)	44.9	44.5	45.0
American Society of Anesthesiologists score	2.7	2.7	2.7
Operative time (min)	177.8	131.6	186.9

Table 8 Multivariate Regression Logistical Analysis

Risk Factor	p Value	Odds Ratio	95% Confidence Interval
Philadelphia collar	<0.05	33.96	2.94–392.96
Neurology (partial or complete)	0.61	0.69	0.16–72.15
Corticosteroids	0.43	3.42	0.16–72.15

largely depended on surgeon preference. Factors such as poor bone quality, corticosteroids, tenuous fixation, and unstable injury patterns dictated whether or not a cervical orthosis was utilized.

This is the largest study of its kind with 90 patients; however, several study factors did not reach statistical significance. Multivariate analyses of known risk factors for SSI did show an upward trend for smoking and use of corticosteroids but lacked any real statistical significance. It may be that a larger cohort would increase the power of the study and more accurately define the contribution of the other factors apart from the use of a collar.

The quality of retrospective versus prospective research studies has been the long-standing subject of many articles in the epidemiological and clinical literature.[5] In particular, retrospective data, usually obtained through medical record review, are fraught with the problems of missing data, conflicting data, and illegibility.[6] In our study, we adhered to strict, well-defined criteria for diagnosing infection from the medical records. Those patients who did not fit the criteria exactly were placed into the noninfected group, which may reflect a significant underestimation of the actual number of postoperative SSIs. Similarly, those patients who developed infection late after leaving our spinal referral center may also have been classed incorrectly as noninfected. From our experience, loss of follow-up may occur after patients are transferred back to their referring hospital, many of which are located in remote rural centers. A quality prospective trial may eliminate these problems with lost follow-up and inaccurate medical record interpretation.

In summary, this study demonstrates a definite causal relationship between wound infection and the use of Phila-delphia collars after posterior cervical spine surgery. We recommend that hard collars be used only on carefully selected patients, namely those with upper cervical spine instability in the postoperative period. We believe that no cervical orthotic device is necessary when solid fixation is achieved and that a halothoracic vest may be an effective option for mid to lower cervical spine instability. As a result of this study, the senior author has changed her current clinical practice, and we look forward to seeing the results of these changes.

Disclosures
Matt Barnes, None
Sue Liew, None

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