Risk factors for wound infection in surgery for spinal metastasis

Abstract
Wound infection rates are generally higher in patients undergoing surgery for spinal metastasis. Risk factors of wound infection in these patients are poorly understood.

Purpose
To identify demographic and clinical variables that may be associated with patients experiencing a higher wound infection rate.

Study design
Retrospective study with prospectively collected data of spinal metastasis patients operated consecutively at a University teaching hospital, adult spine division which is a tertiary referral centre for complex spinal surgery.

Patient sample
Ninety eight patients were all surgically treated, consecutively from January 2009 to September 2011. Three patients had to be excluded due to inadequate data.

Outcome measures
Physiologic measure, with presence or absence of microbiologically proven infection.

Methods
Various demographic and clinical data were recorded, including age, serum albumin level, blood total lymphocyte count, corticosteroid intake, Malnutrition Universal Screening Tool (MUST) score, neurological disability, skin closure material used, levels of surgery and administration of peri-operative corticosteroids. No funding was received from any sources for this study and as far as we are aware, there are no potential conflict of interest-associated biases in this study.

Results
Higher probabilities of infection were associated with low albumin level, 7 or more levels of surgery, use of delayed/non-absorbable skin closure material and presence of neurological disability. Of these factors, levels of surgery was found to be statistically significant at the 5% significance level.

Conclusions
Risk of infection is high (17.9%) in patients undergoing surgery for spinal metastasis. Seven or more vertebral levels of surgery increases the risk of infection significantly ($p < 0.05$). Low albumin level, and presence of neurological disability appear to show a trend towards increased risk of infection. Use of absorbable skin closure material,age, low lymphocyte count, peri-operative administration of corticosteroids and MUST score do not appear to influence the risk of infection.
Keywords: Spinal metastases, Spine tumour, Spinal wound infections, Surgical complications

Introduction

Multilevel adult spinal surgery has a high risk of postoperative wound infection of up to 5.5% (1).

Surgical treatment of spinal metastasis usually involves greater risk of wound infection (2,3,4,5,6,7) compared to other types of spinal surgery. The risk factors for wound infection in these patients are poorly understood. A study is presented involving 95 patients surgically treated for spinal metastasis. The objective of the analysis was to identify demographic and clinical variables which may be associated with these patients experiencing a higher wound infection rate.

Methods

This is a retrospective study with prospectively collected data of 98 patients, operated consecutively. Patients with spinal metastasis were all surgically treated from January 2009 to September 2011, at a University Teaching Hospital which is a tertiary referral centre for complex spinal problems. All patients underwent posterior surgery. Only six patients underwent combined anterior and posterior column reconstruction.

Three patients had to be excluded from the study due to inadequate data. Ninety five patients (51 males, 44 females) were included in the analysis, aged from 19 to 87 years. For each patient, the following characteristics were recorded: age (in years), serum albumin level, blood total lymphocyte count, corticosteroid intake, MUST (Malnutrition Universal Screening Tool) score - a recognised nutritional score used in the United Kingdom (8,9), neurological disability due to spinal cord or cauda equina compression (Frankel grading), skin closure material used and levels of surgery. Corticosteroids were administered as per United Kingdom NICE guidelines for metastatic spinal cord compression (10).

Additional demographic and clinical data were also recorded on all patients, including gender, type and location of tumour, administration of therapies such as radiotherapy, co-morbidities and other complications were recorded. These variables were not included in the statistical analysis to ensure that the model was not over-fitted by inclusion of too many variables for consideration in a limited sample size. Variables were excluded either on clinical grounds, or on the grounds that they did not discriminate adequately between cases. None of the patients underwent radiotherapy in the immediate post-operative period. None of the patients who developed an infection underwent radiotherapy before the onset of infection.

Only three patients suffered from diabetes, hence this factor was also excluded in the analysis. Also, operative blood loss was not included in the analysis, as cell saver technique was used in some patients who had significant amounts of blood loss and we were not able to determine the blood loss accurately. Post-operative blood loss measurements were not available in all patients, hence this was also not considered.

Low serum albumin and reduced lymphocyte counts have been reported to increase infection rates in patients undergoing elective joint replacement surgery(11). Serum albumin levels below 35g/L were classified as *Low*. Lymphocyte counts below 1.5×10^9/L were classified as *Low.* MUST score was categorised as either zero or non-zero. Skin closure material was categorised as either absorbable material (vicryl) or delayed/non-absorbable material (monocryl, prolene, nylon or staples). Frankel grading was categorised as Grade C, Grade D or Grade E, with Grade C being the reference category. Level of surgery was dichotomised into 6 vertebrae or fewer (categorised as *Low*), and 7 vertebrae or more (categorised as *High*); the cut-off for the dichotomisation process corresponding to the optimum combination of sensitivity and specificity being identified by means of a ROC analysis (Figure 1). The outcome variable was a dichotomised measure corresponding to the presence or absence of microbiologically proven infection.

Statistical analysis was undertaken using IBM SPSS for Windows, Version 18.0. A series of binary logistic regression analyses was undertaken on the data. Initially a series of uncontrolled models, each including one of the above factors and covariates, was derived, as a screening process to identify potentially important predictors of infection. Factors and covariates which appeared to exhibit a substantive level of significance with the outcome measure were then carried forward for consideration in a multiple logistic regression analysis, with a final model derived using a modelling strategy with variable selection based on likelihood ratio considerations.

Results

The characteristics of the sample are summarised in Table 1. All the patients who developed infection developed it in their posterior spinal wounds. Ten out of the seventeen patients who developed infection required surgical treatment.

For the level of surgery variable, ROC analysis determined that a nominal cut-off of 6.5 vertebrae (i.e. corresponding to a classification of 6 or fewer as *Low* and 7 or more as *High*) resulted in the optimum combination of sensitivity (82.4%) and specificity (41.0%). It may be shown that dichotomising the surgery level variable at different points leads to sub-optimal combinations of sensitivity and specificity. The area under the ROC curve (Figure 1) was found to be 0.70; indicating that number of vertebrae is reasonably good at discriminating between outcomes.

Uncontrolled binary logistic regression analysis found that albumin level, level of surgery (dicohotomised as above), use of absorbable skin closure material and presence of neurological disability to be substantively associated with infection (Table 2); with higher probabilities of infection associated with low albumin level, high level of surgery, use of delayed/non-absorbable skin closure material and presence of neurological disability. Of these factors, level of surgery was additionally found to be statistically significant at the 5% significance level.

All factors indicating a degree of substantive association with the outcome measure were carried forward for consideration in a multiple logistic regression model. However, the multiple logistic regression model retained only *level of surgery* as a significant factor: i.e. low albumin, delayed/non-absorbable skin closure materials and presence of neurological disability did not exhibit statistical significance when controlling for other factors. The final model was hence identical to the univariate model for *level of surgery* above. Thus at best estimate the odds of patients experiencing an infection are about 3.3 times greater in patients with high levels (7 or more) of surgery than in patients with low levels (6 or fewer) of surgery.

Under this model, 82.1% of cases were correctly classified. Hence, the model appears to fit the data reasonably well. Furthermore, due to the relatively small number (17) of cases of infection, parameter estimates arising from a logistic regression model with few predictors are likely to be more reliable than those arising from a model with a large number of predictors.

Discussion

Our study shows a high level of wound infection (17.9%) in this group of patients compared to other types of spinal surgery. McPhee et al. (2) showed an infection rate of 20% in their study involving 75 patients who underwent surgery for metastatic disease of spine. As far as we know, McPhee's study is the only similar study available in the English literature to compare results with our study. The infection rates in spinal metastasis surgery range from 7% to 32% in various studies in the past (2,3,4,5,6,7). Higher rate of wound infection is expected in these patients, as the physiology is not normal in most of them.

Our study shows that the number of levels operated has a significant influence on risk of infection, with seven or more levels of surgery increasing the risk significantly, (p=0.034; odds ratio (OR)=3.28), compared to lower levels of surgery. McPhee et al. suggest that number of levels of surgery did not statistically contribute to risk of infection. However, it is not quite clear what method of analysis they have used. It would appear logical that the patients requiring higher levels of surgery have more tumour load and hence would have less normal physiology, making them more susceptible to infection. As these patients require bigger incisions, this could also increase the risk of infection. Combined anterior and posterior surgery could be considered in these patients to decrease the size of their posterior wounds, thereby decreasing the risk of infection.

Nutritional deficiencies are known to occur in these patients, particularly low serum albumin (12). Lymphocyte count has been shown in the past to be an indicator of nutritional status (13). Dickhaut et al. (14) have shown that low serum albumin and low lymphocyte count increased the risk of wound complications in ankle amputations. Low lymphocyte count did not increase the risk of wound infection in our study as in the McPhee study. Our study shows a substantive trend towards developing infections in patients with low serum albumin levels (p=0.129; OR=2.29). McPhee et al. showed a similar trend with low serum albumin. Therefore, pre-operative correction of nutritional deficiencies should be considered in these patients wherever possible.

Neurological disability in our study was also substantively associated with a high probability of infection (p=0.135; OR=2.51). This was not the case with McPhee's study. Patients with neurological disability would appear to be more susceptible to infection, as their normal defence mechanisms to skin ischaemia could be diminished and their wounds could be stretched more as they are moved passively, which could affect healing. Measures should be taken to avoid these problems.

Use of absorbable skin suture material (vicryl) is associated with a lower probability of infection in our study (p=0.202; OR=0.49). Although this is not significant at the 5% significance level, this finding at least appears to show that the use of absorbable material like vicryl for skin closure does not increase the risk of infection compared to the use of delayed/non absorbable materials. Although this would appear relevant, as far as we know this information was not looked at in other similar studies in English literature involving patients with surgery for spinal metastasis.

Corticosteroid administration as per NICE guidelines did not appear to increase the risk of wound infection in our patients. McPhee et al. showed increased risk of infection with corticosteroid administration in their patients, although it is not clear what guidelines they had used for their corticosteroid administration. Factors such as age and MUST score did not appear to influence the risk of infection in our patients.

Peri-operative blood loss was found to be a significant factor influencing the risk of developing infection in the McPhee study. Although, we started recording this data in our initial data collection process, we abandoned it due to poor reliability of this data, as cell saver technique was used intra-operatively in many patients with high blood loss, and the post-operative blood loss record was not available for all patients.

Peri-operative radiotherapy significantly increased risk of infection in previous studies (2,3,6,7,15). No patients underwent radiotherapy in the immediate pre-operative period. There is now an increasing awareness among oncologists and surgeons about the detrimental effects of radiotherapy in the immediate pre-operative period. Post-operative radiotherapy was started in our patients only after the wound was considered to be healed. No patients developed infection after the onset of post-operative radiotherapy.

No funding was received from any sources for this study and as far as we are aware, there are no potential conflict of interest-associated biases in this study.

Conclusion

Risk of infection is high (17.9%) in patients undergoing surgery for spinal metastasis compared to other forms of spinal surgery. Levels of surgery of seven or above vertebral levels increase the risk of infection significantly (p‹0.05). Low albumin level, and presence of neurological disability (spinal cord / cauda equina compression) appears to show a trend towards increased risk of infection although they do not appear to reach statistically significant levels. Absorbable skin closure material does not appear to increase the risk of infection. Factors such as age, low lymphocyte count, peri-operative administration of corticosteroids (as per NICE guidelines) and MUST score does not appear to influence the risk of infection in these patients.

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Table 1

Total sample size *n*=95	
Mean age in years (SD)	60.1 (12.8)
Factor	Frequency (%)
Albumin low	40 (42.1%)
Lymphocyte low	63 (66.3%)
Corticosteroid intake	69 (72.6%)
MUST score non-zero	16 (16.8%)
Surgery level high	39 (41.1%)
Absorbable skin closure material	47 (49.5%)
Neurological disability	57 (60.0%)
Frankel mobility Grade C	23 (24.2%)
Frankel mobility Grade D	35 (36.8%)
Frankel mobility Grade E	37 (38.9%)
Infection	17 (17.9%)

Table 1: Descriptive characteristics of sample

Table 2

Factor/covariate	p-value	Odds ratio	95% CI for odds ratio
Age	0.637	1.01	(0.91, 1.05)
Albumin low	0.129	2.29	(0.79, 6.65)
Lymphocyte low	0.333	1.82	(0.54, 6.12)
Corticosteroid intake	0.328	1.95	(0.51, 7.44)
MUST score non-zero	0.420	1.69	(0.47, 6.08)
Surgery level high	0.034	3.28	(1.09, 9.81)
Absorbable skin closure material	0.202	0.49	(0.17, 1.47)
Neurological disability	0.135	2.51	(0.75, 8.40)
Frankel mobility			
Grade C (reference)			
Grade D	0.884	0.92	(0.31, 1.87)
Grade E	0.377	0.60	(0.19, 2.76)

Table 2: Statistical significance, odds ratios and associated confidence intervals in uncontrolled logistic regression models using infection as outcome measure