ABSTRACT

Objectives: Bone morphogenetic protein (BMP) used in anterior cervical spinal fusion procedures causes an inflammatory response resulting in upper airway obstruction between postoperative days 4-7. The purpose of this study is to determine the incidence and severity of airway complications associated with use of BMP, the associated clinical outcomes, morbidities and mortalities following its use, and to create a clinical awareness of patients with acute airway obstruction associated with the use of BMP in cervical spinal fusion.

Methods: This is a retrospective study of 260 patients who underwent cervical spinal fusion procedures with BMP from 2004-2009 and 520 patients, matched on procedure, who underwent cervical spinal fusion procedures without BMP during the same period at a tertiary care center. The two groups were compared on multiple outcome variables: hospital length of stay (LOS), incidence of airway obstruction, unplanned intubations after surgery, tracheotomies, intensive care unit (ICU) admissions, hoarseness, dyspnea, respiratory failure, dysphasia and dysphagia, readmissions, and need for percutaneous endoscopic gastrostomy (PEG) tubes. All outcome variables that were binary in nature were analyzed using linear logistic regression analyses predicting use of BMP. Deaths up to 90 days post surgery were analyzed with a Cox proportional hazards model. Variables significantly related to BMP use were used as covariates in the above analyses.

Results: Patients that underwent cervical procedures with BMP were noted to have significantly longer hospital stays (7.2 ± 1.1 days vs. 4.3 ± 5.2 days, p < 0.001), and greater costs ($129,483 versus $74,974, p < 0.001) than the control group (Table 1). Tracheotomies (Odds Ratio = 3.79, p-value = 0.021), unplanned intubations after surgery (2.81, 0.008), dysphagia (8.94, 0.001), dyspnea (2.43, 0.001), and respiratory failure (3.35, 0.001) were all significantly associated with the BMP group (Table 2 & Figure 1). In addition, hospital readmissions (1.96, 0.040), ICU admissions (3.05, 0.001), and 90 day mortality rates (Hazard Ratio = 2.44, p = 0.047) were significantly worse for the BMP group.

Conclusions: Acute airway obstruction in the postoperative period following cervical spine fusion using BMP is a complication of its use. Due to the degree of obstruction and difficulty with intubation postoperatively, a clinical awareness is necessary to effectively manage these patients. Collaborative efforts between the spine surgeon, anesthesiologist and the otolaryngologist are required for management of the complications that occur after surgery.

RESULTS

<table>
<thead>
<tr>
<th>Outcome</th>
<th>BMP Patients</th>
<th>Non-BMP Patients</th>
<th>BMP p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS</td>
<td>7.2 ± 1.1 days</td>
<td>4.3 ± 5.2 days</td>
<td>0.001</td>
</tr>
<tr>
<td>Cost</td>
<td>$129,483</td>
<td>$74,974</td>
<td>0.001</td>
</tr>
<tr>
<td>Death Within 90 Days</td>
<td>11/260</td>
<td>9/519</td>
<td>0.047</td>
</tr>
</tbody>
</table>

Table 1. Hospital stays, costs, and deaths within 90 days post surgery were significantly worse for the BMP group when compared with the control group.

INTRODUCTION

BMP acts as an osteoinductive substance to promote bone creation and remodeling. Clinical use of recombinant human bone morphogenetic protein-2 (rh-BMP-2, INFUSE® Bone Graft, Medtronic Spinal and Biologics, Memphis, TN) on an absorbable collagen sponge (ACS) carrier was FDA approved in 2002 as an autograft replacement for fusion of the anterior lumbar spine. BMP use increases the likelihood of arthrodesis allowing it to be useful for patients with a higher risk of pseudoarthrosis, nonunion, and for patients with a previous failed cervical spinal fusion procedure. The usage of BMP across the United States has increased from 0.69% of all fusions in 2002 to 24.89% of all fusions in 2006. Although not approved for use in the cervical spine, 16.38% of cervical spinal fusions performed in the United States in 2006 have utilized BMP.2 Due to their potent osteoinductive capabilities, concerns arise with the use of BMP in cervical spinal fusion, such as diffuse soft-tissue swelling causing airway complications (Figure 2).

The finding of postoperative cervical soft tissue edema following the use of BMP in cervical spinal arthrodesis has been reported to occur in a significant percentage of cases.1,2,3,4 These swelling complications typically occurred in a delayed fashion, 4 - 7 days after a seemingly uneventful surgery.2 Due to the progressive nature of the clinical course and treatment of patients receiving BMP in cervical spine procedures.

Table 2. Summary of assessment of BMP cases versus non-BMP cases and their relationship to specific complications. The occurrence of tracheotomies, unplanned intubations after surgery, readmissions, dysphagia, dyspnea, and respiratory failure were all significantly related to use of BMP in the cervical spine.

CONCLUSION

We found BMP use in cervical spine fusions to be significantly associated with an increased incidence of tracheotomies, unplanned intubations after surgery, dysphagia, dyspnea, respiratory failure, ICU admissions, hospital readmissions, as well as significantly longer hospital stays and higher hospital stay costs. Most importantly, we found BMP use in the cervical spine to be significantly associated with a worse 90 day mortality than the control group.

This is the first study to specifically look at the incidence of compromised airways, intubations, tracheotomies, ICU admissions, hoarseness, dyspnea, respiratory failure, dysphagia, readmissions, need for PEG tubes, length of stay, costs, and deaths up to 90 days post surgery following BMP use in cervical spinal fusions. Otolaryngologists are in the unique position of managing acute airway complications. Because of the increased use of BMP in cervical spine procedures, otolaryngologists will be called to manage acute airway complications and subsequent swelling difficulties, postoperatively. To effectively do so, the otolaryngologist must be aware of the clinical course and treatment of patients receiving BMP in cervical spine procedures.

REFERENCES