

## Introduction

Pseudoarthrosis in spine surgery is a major cause of patient morbidity, causing post-operative chronic pain and requiring further surgery. Biologic agents have demonstrated improved rates of successful arthrodesis. rhBMP-2 (BMP) is FDA-approved for anterior lumbar surgery but used off-label in other settings. In this study, the authors review their experience with BMP in anterior cervical surgery patients at high risk for pseudoarthrosis.

## Methods

All patients undergoing anterior cervical fusions with discectomy or corpectomy by the senior authors from Jan 2005-June 2014 were retrospectively reviewed. Operative notes were used to determine use of BMP. Patients received polyetherether ketone cages or allograft with BMP-impregnated collagen sponge. Fusion status at last follow-up was determined. Arthrodesis was defined as clear bone growth on radiograph or CT scan without movement of the fused segment on dynamic imaging. Statistical analysis was performed on Microsoft Excel and GraphPad.

**Table 1**

Characteristic	n
Average age	55.0±10.3
Number of males	106 (48.6%)
Total number of patients with ACDs	164
Total number of patients with corpectomies	53
Average dose of BMP implanted	0.78±0.56 cc
Average dose of BMP per level	0.41±0.26 cc
Patients with preoperative motor deficit	38 (45.9)
Average follow up duration	10.3±8.3 months
Smokers	70 (32.3%)
Average Charlson Comorbidity Index	1.54±1.41
Diagnosis of myelopathy	115
Diagnosis of radiculopathy	102

Demographics

## Results

Seven hundred eighty-nine records were reviewed; 217 patients representing 412 levels received BMP with a mean dose of 0.78+/-0.59 mg/level. At mean follow-up of 10.2±8.3 months, 88.6% had solid arthrodesis. Discectomy patients fused more frequently than corpectomy patients (86.0%, 54.7% respectively, p<0.0001). There was a higher proportion of smokers who failed to fuse than non-smokers, but this failed to reach statistical significance (93.0%, 72.9% respectively, p=0.1536). Three patients required reoperation within 30 days (1 seroma, 2 hematomas), 23 patients had dysphagia, and 11 had postoperative swelling requiring steroids. Most of the patients with postop dysphagia had multilevel operations, but this difference did not reach statistical significance. One patient had persistent hoarseness. Twenty patients (19.0%) developed adjacent segment degeneration. Three patients developed heterotopic ossification. One hundred and four patients had a Charlson Comorbidity Index of 3 or greater.

**Table 2**

Arthrodesis	n
Total levels fused	322 (78.2%)
Total levels not fused	33 (8.0%)*
Overall patient fusion rate	88.6%
ACDF fusion rate	86.0%
Corpectomy fusion rate	54.7%
	p<0.0001
Fusion rate for smokers	72.9%
Fusion rate for nonsmokers	93.0%
	p=0.1536
	*24 patients had no record regarding fusion or nonfusion
1-level ACDF fusion rate	91.3%
2-level ACDF fusion rate	100%
3-level ACDF fusion rate	100%
4-level ACDF fusion rate	50%
1-level corpectomy fusion rate	88.9%
2-level corpectomy fusion rate	66.7%
3-level corpectomy fusion rate	0%

Arthrodesis rates

**Table 3**

Complication	N
Total occurrence of dysphagia	23 (10.6%)
In single level ACDF	6 (26.1%)
In multi-level ACDF or corpectomy	18 (78.3%)
	p=0.1831
Total occurrence of postoperative swelling	11 (5.1%)
Postoperative hematomas	3 (1.4)
Postoperative seromas	2 (0.9%)

Complications

## Conclusions

The authors utilized BMP to enhance arthrodesis in a high-risk cohort of patients undergoing anterior cervical surgery. Our fusion rate compares favorably with historical controls and the complication rate is acceptably low using smaller doses of BMP than previously reported. Three patients required reoperation for BMP-related complications. BMP can be safely implanted in the anterior cervical spine and serves as an important adjunct to promote bony arthrodesis in high-risk patients. Further analysis of the author's data will reveal if there is a relationship between dose and complication on the one hand and arthrodesis on the other.

## Learning Objectives

In a high-risk population of patients undergoing spinal fusions, pseudoarthrosis rates are higher than the baseline population. The study indicates the safety of BMP and efficacy to prevent pseudoarthrosis in such a population.

**Table 4**

Author	Year	Fusion rate	Complication rate (if given)
Yson	2017	93%	
Schroeder	2017	96.10%	
Li	2016	87.10%	
		90.3	
Arnold	2016		
Choi	2016	92.2	
		91.1	
Lau	2015	93.7	5.7
		92.9	20.3
Shriver	2015	97.4	
Bydon	2014		12.2
Luszczzyk	2013	91	
		91.6	
Pereira	2013		6.7
Park	2013	87.2	
Lu	2016		40
			44
Song	2012	100	18.6
Papadopoulos	2006	95.6	4.3
Cheng	2005	100	52.9
Yue	2005	925.6	73.2
Smucker	2006		27.5
Wang	2001	82%	
Wang	2000	100	
Shields	2006		23.2

Historical Controls