

## **Bone Morphogenetic Protein Utilization in Long Bone Nonunions among Trauma Centers and between Orthopaedic Traumatologists: Is it as Popular or as Successful as We Think?**

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**INTRODUCTION:** Bone morphogenetic protein (BMP) has become increasingly popular in the management of long bone nonunions although its advent has been shadowed by controversy and concern for complications. The purpose of this study is to 1) evaluate the efficacy of BMP and its impact on patient outcomes and complications and 2) describe the utilization of BMP in the management of long bone nonunions over time in trauma centers among practicing orthopaedic traumatologists.

**METHODS:** This was a multicenter (12 centers) retrospective review of adults with long bone (humeri, femurs, tibias) nonunions that were treated with either autograft or allograft, both with and without BMP. Autograft included iliac crest, RIA, and local graft. Inclusion criteria included patients >18 years old requiring surgical intervention for a long bone nonunion. Exclusion criteria was follow up <180 days. Patient demographics, injury characteristics, surgical details, treating facility, operating surgeon date of surgery, complications, and outcomes were collected.

**RESULTS:** There were 970 nonunion cases, 157 cases with BMP (33 humeri (21%), 61 femurs (38.9%) and 59 tibias (37.8%)) and 813 cases without BMP (222 humeri (27.8%), 247 femurs (29.7%), 344 tibias (42.3%)). Over half of the injuries were initially closed in both groups (56.69% in BMP and 50.55% non-BMP) and there was a significant association between the presence of segmental gap defect and the decision to utilize BMP as a biologic augment ( $p=0.016$ ). In both BMP and non-BMP cohort, atrophic nonunion was the most common type of nonunion (42.7% and 42.9%), followed by oligotrophic (33.1% and 38.4%) then hypertrophic (14.6% and 2.8%). Patients in the BMP cohort tended to be female (53.50% vs. 39.85%,  $p=0.029$ ), slightly older (54 years vs. 48 years,  $p=0.004$ ), and had higher BMIs (31.12 vs. 28.44,  $p=0.002$ ). There was no difference in union rate (84.71% vs. 79.21%,  $p=0.127$ ), time to union (197 days vs. 205 days,  $p=0.842$ ), or rates of complications (43.31% vs. 40.22,  $p=0.371$ ). The median length of stay was 2 days for each group; however, there was greater variability within the BMP cohort than the non-BMP cohort (IQR 1,4 vs. 2,4;  $p=0.013$ ). BMP utilization significantly increased after 2010 (3.8% vs. 41.4%). However, when interpreting these findings, it is important to recognize that 78% of utilization was driven by 3 centers alone and 42% of cases driven by a select number of surgeons at those centers.

**DISCUSSION AND CONCLUSION:** BMP patients tended to be older and female. Nearly half of BMP treated nonunions were hypertrophic and oligotrophic. There were no significant differences in union rate, time to union, or complications between the BMP cohort and non-BMP cohort. Despite this, BMP utilization has been increasing since 2010, although utilization is driven by a limited number of centers and even fewer practicing surgeons at those centers. Given the cost of BMP-2 without an improvement in outcome measure of union rate, time to union, or LOS surgeons should carefully consider routine utilization.