The Effect of rhBMP-2 on Allograft Union and Remodeling in a Corpectomy Model

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Introduction:
Anterior corpectomy with instrumentation and fusion is common in the treatment of fractures, tumors, infections, and kyphotic deformities of the thoracic and lumbar spine. Both autogenous (iliac crest, rib or fibula) as well as allogeneous strut grafts are utilized in the reconstruction. One of the advantages of autogenous bone is thought to be the endogenous cells and growth factors present within the graft to promote union. Recombinant human BMP-2 (rhBMP-2) in a collagen matrix has been evaluated as a means of increasing the likelihood of arthrodesis in an interbody (single motion segment) allograft reconstruction. However, we are unaware of similar studies of cortical strut allograft healing after vertebral corpectomy. The purpose of this study was to evaluate healing and incorporation of strut allografts after lumbar corpectomy, and to evaluate the use of rhBMP-2 to augment graft union and remodeling.

Methods:
This study was approved by the Animal Subjects Committee and complies with all regulations for the humane treatment of animals. Sixteen calves (age 3 weeks) underwent L3 corpectomy and strut allograft reconstruction. Tibial allografts were harvested from 4 additional animals and stored at 0°C prior to implantation. rhBMP-2 impregnated collagen sponges were placed to fill the empty medullary canal of the allograft in eight animals (5-6 sponges per graft, 0.6mg/sponge). Eight “control” animals had the allograft filled with autogenous cancellous bone from the excised vertebral body. The graft was stabilized with an ATL Z plate (Medtronic Sofamor Danek, Memphis, TN) construct between L2 and L4. The average length of the allograft strut was 36 ± 3 mm. The procedures were performed in an alternating order between groups. After a four-month survival period, the lumbar spines were harvested en bloc from L2-L4 for radiographic and biomechanical evaluation. Computed tomographic (CT) spiral scans were obtained with 1 mm cuts (hardware removed before scanning). Coronal and sagittal reformatted images were also obtained and evaluated for the presence or absence of allograft union (Fig. 1).

Results:
The CT scans reveal allograft incorporation into the vertebral endplates in all specimens with the exception of one pseudoarthrosis in the control (autograft-filled) group. Image analysis demonstrated significantly different patterns of bone formation within the strut allografts. The BMP-treated group had more bone at the ends of the graft, while the autograft-filled struts maintained a uniform distribution of bone throughout the length of the strut (Fig. 3). Biomechanical testing suggested possibly greater construct stability in the BMP-treated group compared to the control. The 95% confidence intervals for all modes of nondestructive testing confirmed that the stability of the fusion in the BMP group was at least as great as the controls. (Fig. 4). Torsion testing to failure demonstrated similar trends.

Discussion:
This study confirms the healing and incorporation of large cortical strut allografts supplemented with rhBMP-2 in a corpectomy model. The fusion in the BMP group appears to start at the vertebral endplates, with progressive bone formation toward the center of the allograft. When comparing rhBMP-2 impregnated allografts to those filled with autogenous bone graft, the formation of bone within the allograft as well as the structural integrity of the host-allograft junction appears to be equivalent between treatments. These results are similar to those previously seen in shorter interdiscal grafts/spacers, suggesting the efficacy of BMP in these large segment reconstructions performed after a vertebral corpectomy.