THE RAT AS A MODEL FOR INTERTRANSVERSE PROCESS SPINAL FUSION

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INTRODUCTION:
A well characterized, cost effective, in vivo lower animal model would allow the rapid evaluation of the osteogenesis underlying spinal fusion by potentially osteoinductive growth factors, DNA vectors, or implant biomaterials. The feasibility of posterolateral intertransverse process fusion in the rat is unknown.

This is a pilot study to explore the feasibility of the posterolateral intertransverse process fusion procedure in a rat and to compare the celerity of fusion provided by rhBMP-2 to that of autogenous iliac crest bone graft.

MATERIALS & METHODS:

Materials:

- 0.05 mg/ml rhBMP-2 in buffer was drip applied to the collagen sponge (Helistat) to the point of saturation (~ 0.16 ml per 0.5 cm by 1 cm sponge). MFR buffer of glutamic acid, glycine, sucrose, injectable H2O.
- 0.5 cm by 1 cm rectangular piece of collagen sponge (Helistat) cut for each implant side (2 per rat).
- For the rats treated with autogenous bone, the entire iliac crest composed of cortico-cancellous bone from both sides was obtained, morselized, and placed in the fusion site of the same donor side.

Methods:

Twenty Sprague Dawley mature female rats (220-250 g) underwent L4-L5 posterolateral transverse process fusion. Through a midline incision following anesthesia, the transverse processes, lamina, and intervening apophyseal joints were exposed. Only the transverse processes were decorticated (lamina, facet joints were left intact without decortication). The treatment conditions were: 'rhBMP-2 & buffer & collagen', 'autogenous iliac crest bone', 'decortication & collagen & buffer', 'decortication & collagen only', 'exposure-only', which still had intersegmental motion at 8, and 12 weeks. The sites implanted with autogenous iliac crest bone graft were solid only after 8 weeks. These preliminary data provide the foundation for the study of spinal fusion using various osteoinductive factors, carriers and surgically or genetically altered rat models.

RESULTS:

<table>
<thead>
<tr>
<th>Conditions</th>
<th>3 weeks</th>
<th>4 weeks</th>
<th>8 weeks</th>
<th>12 weeks</th>
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<tr>
<td>D &amp; rhBMP-2 &amp; Collagen</td>
<td>2/2</td>
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<tr>
<td>Exposure Only</td>
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<tr>
<td>Decortication Only (D)</td>
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<td>D &amp; Collagen</td>
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<td>0/1</td>
<td>0/1</td>
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<tr>
<td>D &amp; Collagen &amp; Buffer</td>
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</tr>
<tr>
<td>Autogenous Iliac Crest Bone</td>
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<td>0/2</td>
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</tr>
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</table>

All spines implanted with rhBMP-2 were solidly fused by 3 and 4 weeks by radiographic and manual testing. At 4 weeks each segment had a prominent fusion mass bilaterally that was readily visible radiographically.

None of the exposure-only, decortication-only, decortication & collagen & buffer, or decortication & collagen only sites were fused by 8 weeks. At 12 weeks, still none of these was fused. There was some bone formation in one of the collagen-only implanted sites and no radiographic evidence of bone formation in any of the others.

Sites implanted with autogenous bone graft underwent complete fusion by 8 weeks. All rhBMP-2 implanted sites demonstrated earlier and larger fusion masses radiographically compared to autografted segments.

CONCLUSIONS:

Posterolateral intertransverse process fusion can be successfully performed in the rat. Intertransverse process fusion is not readily achieved without induction from either rhBMP-2 or autogenous bone graft. Sites implanted with rhBMP-2/collagen composites are solid by at least 4 weeks compared to those with collagen-only or exposure-only which still had intersegmental motion at 8 and 12 weeks. The sites implanted with autogenous iliac crest bone graft were solid only after 8 weeks. These preliminary data provide the foundation for the study of spinal fusion using various osteoinductive factors, carriers and surgically or genetically altered rat models.

For primarily biologic questions related to spinal fusion or for screening the osteogenic potential of growth factors and biomaterials, the posterolateral intertransverse process fusion in a rat provides a useful, rapid, and inexpensive model.

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