The Effect of Highly Purified Capsaicin on Normal Articular Cartilage and Rotator Cuff Tendon Healing: An In Vivo Rabbit Study

INTRODUCTION

Pain management in orthopedic surgery has evolved to include direct intra-articular administration of anesthetics, which has proven to be effective (1). Unfortunately bupivacaine and other amino amides used in intra-articular injection negatively affect the cartilage, as documented in clinical case studies (2), animal (3), and in vitro (4) studies. Further, local anesthetics have the potential to adversely affect tendon healing (5).

Therefore, an alternative solution is necessary for post-operative pain management. Capsaicin is a long-acting anesthetic, functioning to decrease sensitivity to mechanical, chemical, or thermal noxious stimuli (6). In the present study, we utilize an in vivo rabbit rotator cuff (RC) repair model to evaluate effects of highly purified capsaicin on normal glenohumeral articular cartilage and supraspinatus tendon healing.

METHODS

Fifty skeletally mature, male New Zealand White rabbits were evaluated at 1 or 18 weeks post-operatively. Animals assigned to the one week group (n=6, cartilage analyses only) were treated with unilateral supraspinatus transection and repair with a single 1mL injection of capsaicin into the glenohumeral joint (GHJ). Contralateral shoulders received no surgery or treatment.

Animals assigned to the 18 week study (n=11 per group) were randomized to one of four groups:

1. Capsaicin injection onto an intact rotator cuff (I+C)
2. Unilateral supraspinatus transection and repair with a single 1mL injection of saline into the GHJ (R+S)
3. Unilateral supraspinatus transection and repair with a single 1mL injection of capsaicin into the GHJ (R+P)
4. Unilateral supraspinatus transection and repair with a single 1mL injection of capsaicin into the GHJ (R+C)

Contralateral shoulders (Sham group) received surgical exposure of the RC but no tendon injury or intraarticular injection.

Using previously described methods (3), one week post-op animals were used for assessment of humeral head articular cartilage proteoglycan (PG) synthesis and content, chondrocyte cell viability, and histology. Eighteen week post-op animals were evaluated with the same cartilage assays as well as with supraspinatus tendon tensile testing (monotonic load to failure test at 0.1mm/sec) and histology.

RESULTS

At 1 week, total PG content, percentage of viable cells, and histopathologic score were similar (p>0.05) between treated and untreated shoulders. Chondrocyte PG synthesis for capsaicin-treated shoulders was 147±43% (p<0.05) of that for contralateral, untreated joints. (Table 1)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>PG Synthesis (ng/µg)</th>
<th>Cell Viability (%)</th>
<th>Maximum Load (N)</th>
<th>Deflection to Max Load (mm)</th>
<th>Work (Nmm)</th>
<th>Stiffness (N/mm)</th>
<th>Maximum Stress (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I+C</td>
<td>9.6 ± 2.1</td>
<td>7.0 ± 2.2</td>
<td>71 ± 1.3</td>
<td>1586 ± 276</td>
<td>373 ± 127</td>
<td>74 ± 11.5</td>
<td>5.8 ± 2.4</td>
</tr>
<tr>
<td>R+S</td>
<td>7.8 ± 2.36</td>
<td>7.8 ± 2.4</td>
<td>71 ± 1.39</td>
<td>1596 ± 286</td>
<td>373 ± 127</td>
<td>74 ± 11.5</td>
<td>5.8 ± 2.4</td>
</tr>
<tr>
<td>R+P</td>
<td>12.0 ± 2.3</td>
<td>12.0 ± 2.3</td>
<td>71 ± 1.39</td>
<td>1596 ± 286</td>
<td>373 ± 127</td>
<td>74 ± 11.5</td>
<td>5.8 ± 2.4</td>
</tr>
<tr>
<td>R+C</td>
<td>16.0 ± 2.3</td>
<td>16.0 ± 2.3</td>
<td>71 ± 1.39</td>
<td>1596 ± 286</td>
<td>373 ± 127</td>
<td>74 ± 11.5</td>
<td>5.8 ± 2.4</td>
</tr>
</tbody>
</table>

TABLE 1: One week biochemistry and cell viability.

At 18 weeks, no differences were seen between groups for chondrocyte PG synthesis (p>0.05, mean across all groups: 112±5.6% of sham treated shoulder) and total PG content (p=0.29, mean across groups: 103.1±21.4% of sham treated shoulder). (Figure 1)

Cartilage cell viability, computed as live cells/total cells normalized to the cell viability of the contralateral sham shoulder, was similar across treatment groups (p=0.697, mean across groups: 102.2±1.1%).

Histologic appearance of humeral heads in all treatment groups were similar (Modified Mankin scale, p=0.785).

CONCLUSIONS

One week following surgery, the cell viability and PG content of capsaicin-treated shoulders were similar to untreated controls. Increased metabolic activity (PG synthesis) may be a direct effect of the drug or a post-surgical inflammatory response. Interestingly, at 18 weeks after surgery, PG synthesis and content as well as cell viability were comparable to contralateral shoulders receiving a sham procedure, suggesting that capsaicin does not cause long term damage to chondrocytes or matrix. Failure strength, as well as structural properties of repaired supraspinatus tendons, irrespective of treatment, were similar (Table 2), suggesting that capsaicin does not have detrimental effects on the quality of tendon healing. The current results indicate that a single injection of highly purified capsaicin into the GHJ does not induce a deleterious response with regard to cartilage matrix metabolism and cell viability, as well as rotator cuff healing; hence, capsaicin may provide a safe alternative to manage postoperative pain.

REFERENCES


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