POST-TRAUMATIC RABBIT KNEE JOINT CONTRACTURES ARE PERMANENT

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INTRODUCTION:
Treatment of joint injuries is often fraught with permanent post-traumatic loss of joint motion, or contractures. Our objective was to describe the natural history of a rabbit knee model of permanent post-traumatic joint contractures produced by 8 weeks of immobilization in combination with a joint injury. Remobilization of up to 32 weeks followed. Two hypotheses were tested: 1) Contractures of all experimental knee groups will be greater than contralateral knees and 2) Contractures of experimental knees after 16 and 32 weeks of remobilization will not be different.

METHODS:
Twenty-four skeletally mature (12 - 15 months old, 5.5 ± 0.6 kg) New Zealand White (NZW) female rabbits had the following operative intervention after approval by the institutional animal care committee. Five-mm-squares of cortical bone were removed from the nonarticular portions of both femoral condyles. An extraarticular 1.6-mm-diameter Kirschner wire (K-wire) was drilled through the tibia, passed posterior to the knee joint, and bent around the femur. The knee was flexed around 150º. The left knee served as an unoperated control.

The rabbits were allowed cage activity (0.1m²) following the operation. A second operation was performed 8 weeks later to remove the K-wire. The rabbits were divided into four groups depending on the time of remobilization (Table 1). At the time of sacrifice, the hind limbs were dissected, leaving all soft-tissue intact from just superior to the patella to 1 cm below the end of the tibial tubercle.

Table 1: Group Description

<table>
<thead>
<tr>
<th>Group</th>
<th>Immobilization</th>
<th>Remobilization</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td>8 weeks</td>
<td>0 weeks</td>
<td>6</td>
</tr>
<tr>
<td>Eight</td>
<td>8 weeks</td>
<td>8 weeks</td>
<td>7</td>
</tr>
<tr>
<td>Sixteen</td>
<td>8 weeks</td>
<td>16 weeks</td>
<td>5</td>
</tr>
<tr>
<td>Thirty-two</td>
<td>8 weeks</td>
<td>32 weeks</td>
<td>6</td>
</tr>
<tr>
<td>CONTROL</td>
<td>N/A</td>
<td>N/A</td>
<td>23</td>
</tr>
</tbody>
</table>

A previously described mechanical goniometer allowing multiple degrees-of-freedom was used to measure in-situ joint angles. The knee was mounted at a flexion angle of 90º and then extended maximally with an applied torque of 0.2 Nm using an MTS Testar II material testing system. The data were recorded as a loss of knee extension, often referred to as a flexion contracture. Statistical analysis was performed with an ANOVA with a posthoc Student-Newman-Keuls test. Significance was set at p < 0.05. Data are presented as mean ± standard deviation.

RESULTS:
The loss of extension for the 4 experimental knee groups and the pooled contralateral limbs are presented in Figure 1. One contralateral knee was excluded due to a chronic anterior cruciate ligament tear. The loss of extension for the experimental knees in the 0 and 8 weeks remobilization groups were significantly greater than the values of the contralateral knees (p < 0.05). The loss of extension for the experimental knees in the 16 and 32 weeks remobilization groups were also greater than the contralateral knees, although they were not statistically significant (p = 0.07). The average loss of extension for the 16 and 32 - week groups were 21º and 20º, indicating a stabilization of the motion loss or joint contracture. These differences were not statistically significant (p > 0.05).

DISCUSSION:
We have presented the natural history of a rabbit knee model of post-traumatic joint contracture induced by a combination of an intraarticular fracture and extraarticular immobilization for 8 weeks. The immobilization was discontinued and remobilization allowed up to 32 weeks, or 4 time frames longer than the immobilization. In this model, a loss of extension, or flexion contracture, was measured at 38º after 8 weeks of immobilization without any remobilization (group zero), which was significantly greater than the contralateral knees (9º). The severity of the contracture decreased with time of remobilization. However, the degree of contracture stabilized between 16 and 32 weeks of remobilization, suggesting that the joint has developed a permanent contracture. This mimics the human scenario of permanent post-traumatic joint contractures.

Other authors have created knee joint contractures in rats or rabbits by immobilizing uninjured knees. However, uninjured rabbit knee joints immobilized 9 weeks regained full range of motion on biomechanical measures 9 weeks after the immobilization was discontinued. Periarticular injuries with immobilization produce joint contractures during the immobilization, but the effect of remobilization in these models has not been reported.

In summary, we have described a rabbit knee model of post-traumatic joint contracture where motion loss appears permanent. Future work will include molecular, biochemical and histological studies on matrix and cell type (myofibroblast) changes in the posterior knee joint capsule. This model will be used for future studies on the mechanisms and treatment of post-traumatic joint contractures.

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REFERENCES: