ACHILLES TENDON STRAIN: RESEARCH FINDINGS WITH CLINICAL IMPLICATIONS
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Key Points
- Calcaneal tendon strain during weight bearing is not altered by tibiotarsal immobilization
- Strain is lessened during the non-weight bearing portion of the gait
- Restricted activity and altered weight bearing may play a more important role in protecting tendon repairs than immobilization alone.

Tendons are susceptible to injury, either due to major overload or repeated subclinical injury. Individual fibres can withstand 2-5% strain before undergoing plastic deformation & permanent elongation. Tendons as a whole can withstand up to 20-50% strain, while still demonstrating a linear response and return to normal length. Under normal usage, tendons are strained only to 25-33% of maximum strength.

Tendons are slow to heal, with no appreciable increase in strength within the first 3 weeks. Strength slowly increases from 3-6 weeks, with slow gains thereafter. Overstressing a tendon repair before adequate healing can result in gap formation and/or repair failure. Tendons undergoing a gap greater than 3mm during the repair process heal at a slower rate, with lower ultimate tensile resistance at 6 weeks compared to tendons healing with no gap.

Some tension is beneficial during tendon healing, especially starting at 3 weeks. Limited physical therapy results in stronger tendon repair, compared to patients treated with immobilization, with faster maturation of collagen, and more rapid restoration of load to failure in mobilized groups. The trend in human medicine is towards early protected weight bearing and physical therapy.

In order to assess the effect of tibiotarsal immobilization on strain within the calcaneal tendon, a study was performed to directly measure strain during trotting in normal canines and after immobilization. A DVRT® strain gauge was implanted on the common gastrocnemius tendon of 6 dogs. Surface EMG, % strain, and ground reaction forces were measured prior to intervention and after immobilization with an external fixator and a cast. Peak vertical force (Fz), vertical impulse, initial, maximum and final strain, and peak-to-peak EMG amplitude were recorded. Data was analyzed using repeated measures analysis of variance and paired t-tests (p ≤ 0.05).

Timing of strain data correlated closely to the hind limb footstrike and EMG activity in all dogs, and maximum tendon strain occurred with peak Fz (figure 1). Continued muscle contraction was evident after immobilization. There was no statistical difference in maximum strain after immobilization compared to normal weight bearing. Minimum strain, both at the beginning and end of the strain curve, was significantly decreased compared to non-immobilized joints (table 1).

Tibiotarsal immobilization did not alter calcaneal tendon strain during weightbearing. Decreased isometric muscle contraction during the swing phase of the gait would account for smaller minimum strain in immobilized joints. In this study, we did not directly correlate strain to tendon force – this would necessitate correlating measured strain with a series of known weights. Clinical benefits of immobilization may result more from initial decreases in weight bearing, as well as post-operative exercise restrictions.
**Figure 1:** Output from a single trial demonstrating timing of curves. EMG data is from the lateral gastrocnemius muscle

![Graph showing strain, EMG, and Fz with FL and HL markers](image)

<table>
<thead>
<tr>
<th></th>
<th>pFz</th>
<th>VI</th>
<th>Initial strain</th>
<th>Peak strain</th>
<th>Final strain</th>
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<tr>
<td>Pre-implant</td>
<td>67.88±10.19\textsuperscript{a}</td>
<td>9.56±1.96\textsuperscript{a}</td>
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<tr>
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<td>7.76±3.11\textsuperscript{a}</td>
<td>3.34±3.60\textsuperscript{b}</td>
<td>6.70±4.37\textsuperscript{a}</td>
<td>3.31±3.55\textsuperscript{b}</td>
</tr>
</tbody>
</table>

**Table 1:** Averaged data for all animals and trials. Values denoted with the same letter are not significantly different. Denoted with consecutive letters are significantly different.
References