

Inflection Point Analysis of Rabbit EDL Tendon for Validating Long-Term Viability of a Passive Force-Amplifying Implant

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Abstract:

During long-term implantation of a passive, force-amplifying implant we are developing for tendon-transfer surgeries, overloading the output tendon could cause an accumulation of tendon damage, resulting in failure due to tendon rupture. In our rabbit model planned for initial long-term validation studies, the output Extensor Digitoralis Longus (EDL) tendon will experience peak isometric loads of 12.7 ± 2.6 N from our implant [1]. We thus sought to determine the load at which fascicle-level damage of the rabbit EDL tendon begins to occur, which we did by finding the inflection point between upward and downward curvature of the tendon's force-strain curve [2].

Six EDL tendons were excised from three adult New Zealand white rabbits. Tendons were clamped into a tensile testing machine, and initial length was recorded while they were under 0.1 N of tension. Tendons were subsequently preconditioned to 2% strain for 10 cycles, then pulled until rupture, all at 0.5% strain/s. The inflection point of the final force-strain curve for each tendon was identified as where the second derivative crossed zero.

The mean $\pm$ standard deviation inflection point load for the EDL tendon was 17.2 ± 3.6 N.

This mean inflection point load is greater ($p < .05$) than the expected peak isometric load on the tendon with our implant in place, with a large effect size between means ($d = 1.5$). Furthermore, we expect rabbits will rarely exert near-peak levels of force. Therefore, there should be little-to-no accumulation of load-induced damage in the EDL tendon body to negatively impact the implant's long-term viability in the rabbit.

Conflict of Interest:

RB is President of OrthoMechanica

References:

[1] Ling H. Developing a Force-Amplifying Implant for Improving Functional Strength Restoration Following Tendon Transfer Surgery. Oregon State University; 2023.

[2] Lee AH, Szczesny SE, Santare MH, Elliott DM. Investigating mechanisms of tendon damage by measuring multi-scale recovery following tensile loading. *Acta Biomater.* 2017;57:363-372. doi:10.1016/j.actbio.2017.04.011