

INTRODUCTION

Several studies have investigated the effects of irradiation on the dose-dependent biomechanical properties of allografts¹⁻⁷. The AATB conducted a survey and found that 29 out of 36 tissue banks use a standard gamma irradiation ranging from 1.0-3.5 Mrad⁷. The purpose of this study is to investigate the biomechanical properties of non-irradiated (NI) and irradiated (IR) peroneus longus (PL) and peroneus brevis (PB) tendons.

METHODS

Preparation of the allografts. Seven pairs of PL tendons and ten pairs of PB tendons were harvested from male and female human cadavers. Ages of cadavers ranged from 13-57 years old with a mean age of 41.6 years old. The left side of each allograft was IR at 1.5-2.5 Mrad, while the right side was kept aseptic and NI.

Biomechanical testing. Allografts were mounted in custom freeze grips, with an active length of 4 cm, both grips were then frozen in liquid nitrogen for 20 seconds before being placed in the MTS model 858 MiniBionix II (Eden Prairie, MN, USA). The expected length of a reconstructed allograft between the tibial and femoral anchors is approximately 4 cm. The allografts were finally pulled in displacement control at a constant displacement of 4 cm/sec. to create a strain rate of 100%/sec. Failure mode was recorded and only specimens showing intra-ligamentous rupture were included in the analysis.

Biomechanical Parameters. The parameters recorded throughout each sample in this study were the force and displacement. From the force and displacement graph, the peak force (N) and the excursion of peak force (mm) were noted. The stiffness (N/mm) was the slope of the linear portion of the graph. From the ultimate load the ultimate stress (MPa) was calculated by dividing the load by the cross-sectional area of the graft, which is calculated from the double loop diameter.

Statistical analysis. Student's t-test was used to compare the matched pairs of allografts. Threshold P-value was set at 0.05.

RESULTS

One IR and 2 NI tendons were statistical outliers due to the failure of the tendons at the grip or pulling through the grip.

Peroneus Brevis. Eight pairs of PB were included. The mean ultimate load for the NI (right side) PB allografts was 1466.2±203.1 N while the IR PB allografts (left side) was 1365.4±303.8 N (Fig.1). The mean ultimate stress for the NI PB allografts was 78.77±20.6 MPa while the IR PB allografts was 73.2±16.20 MPa. The differences between NI and IR ultimate loads and stresses were not statistically significant. The elongation at the peak load for the NI side was 9.8±2.6 mm and 13.2±3.13 mm for the IR side. This paired difference was the only statistically significant difference for all measures. This strain amounts to 33.1% for the IR side vs. 24.4% for the NI side (Fig.2). The structural stiffness for NI was 225.8±46.0 N/mm and 170.9±73.0 N/mm for IR.

Peroneus Longus. The mean ultimate load for the NI PL allografts was 1815.5±1075.1 N while the IR PL allografts was 1660.5±922.0 N (Fig.1). The mean ultimate stress for the NI PL allografts was 93.7±15.6 MPa while the IR PL allografts was 89.1±18.2 MPa. Neither of these differences were statistically significant. The elongation at the peak load for the NI side was 17.3±5.1 mm, and 15.7±3.6 mm for the IR side. The ultimate strain was 43.4% for the NI side vs. 39.3% for the IR side (Fig.2). The structural stiffness for the NI side was 225.7±56.8 N/mm and 203.9±67.0 N/mm for the IR side.

Combined NI vs. IR allografts. The mean ultimate load of all NI allografts was 1846.87±498.3 N while the IR allografts was 1722.73±494.34 N. The mean ultimate stress of all NI allografts was 85.7±19.4 MPa while the IR allografts was 80.74±19.13 MPa. Neither the P-value for the ultimate load nor the ultimate stress was statistically significant.

DISCUSSION

The results demonstrate there is no significant difference between irradiated and non-irradiated PB and PL tendons when exposed to 1.5-2.5 Mrad of gamma irradiation. The only exception to this was the observed elongation of PB. However, this difference is probably of no clinical relevance since the elongation is well beyond the normal expected operating range of an ACL (< 10%).

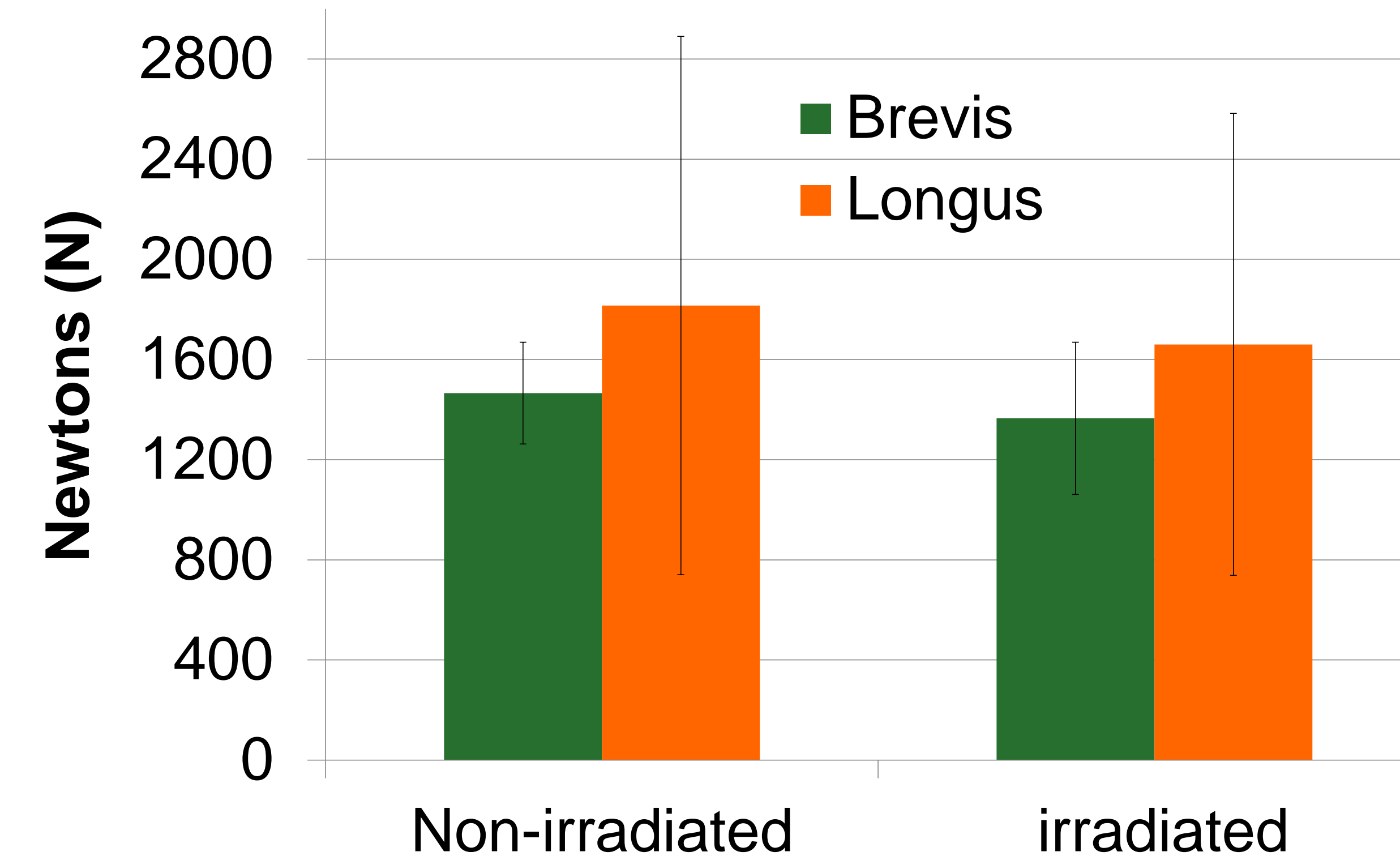


Figure 1: Mean ultimate load (N) comparison between NI and IR peroneus tendons.

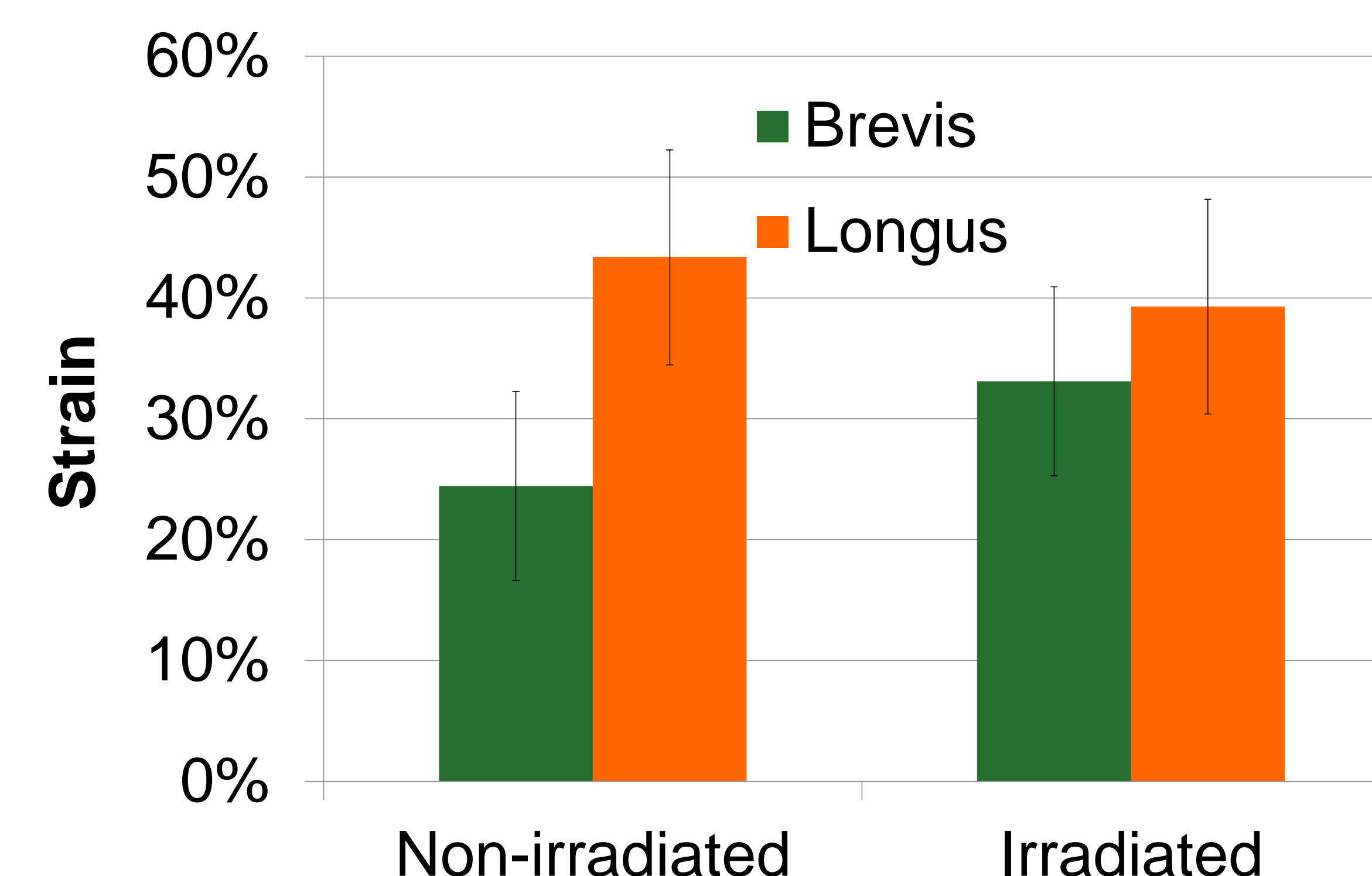


Figure 2: Mean ultimate strain (%) comparison between NI and IR peroneus tendons.

SIGNIFICANCE: Sterilizing allografts with a 1.5-2.5 Mrad dose of gamma irradiation does not significantly alter the biomechanical properties while still providing a suitable level of sterilization.

REFERENCES

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