**Dynamic Effect of the Tibialis Posterior Tendon on the Foot during Cyclic Axial Loadings**

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**ABSTRACT INTRODUCTION:**

The arch structure of the foot aids human gait by supporting the body weight against gravity. The tibialis posterior muscle is believed to be the most important dynamic support of the arch of the foot. However, no previous experimental studies have examined the dynamic effects of the tibialis posterior tendon on the arch of the human foot. The aim of the present study was to investigate the change of the medial longitudinal arch height during cyclic axial loading with activated tibialis posterior tendon force compared to the non activated muscle condition. We hypothesized that the medial longitudinal arch of the foot would be maintained when the tibialis posterior tendon was activated.

**METHODS:**

14 normal fresh frozen cadaveric legs were used. The mean age at the time of death was 82 years (range, 59 to 92). Each leg was cut at the proximal third of the crus. The proximal edge of each specimen was fixed with 2-mm Kirschner wires and mounted by a 5-cm-diameter acrylic tube filled with polymethylmethacrylate resin. The leg was set at the neutral position on the custom jig. A total of 10,000 cyclic axial loadings of 500 Newtons were applied to the longitudinal axis of the tibia using the Materials Testing Machine (AG-1, SHIMADZU, Kyoto, Japan). The frequency of axial loading was set at 1 Hz. The experiments were divided into two groups. The 32 Newtons dynamic loadings were applied to the tibialis posterior tendon (active TP group, n=7). While more than 15 Newtons axial load was applied, the tibialis posterior tendon was pulled proximally by the servomotor. The specimens of another group were investigated without muscle force during cyclic axial loadings (non active TP group, n=7). A 1 mm² square red light emitting diode (LED) was attached to the medial aspect of the navicular with minimum disruption. The displacement of the LED light was monitored via a charge-coupled device (CCD) camera (Figure 1). The image from the CCD camera was converted to the coordinate system. The translational accuracy was 0.06 mm (0.2% full scale).

One cycle was determined the period of over 5 Newtons axial load applied. The navicular heights with initial 5 Newtons axial load and a peak of axial load were recorded in each cycle. It means that the navicular height with minimum and maximal weightbearing, respectively. The arch change was evaluated using the bony arch index (BAI). The BAI was determined by the navicular height to foot length ratio. A low arch was defined as a BAI with weightbearing of less than 0.21. The BAI with minimum and maximal weightbearing were calculated for each 1,000 cycles. We compared BAI with minimum and maximal weightbearing for each 1,000 cycles between active TP group and non active TP group by using a student’s t-test. A p value of 0.05 was chosen as the level of significance.

**RESULTS SECTION:**

The height of the navicular decreased with cyclic axial loading especially in non active TP group. The mean BAs in active TP group were almost constant after 3,000 cyclic axial loadings. The initial BAs with minimum weightbearing were 0.284 ± 0.008 (active TP group) and 0.281 ± 0.015 (non active TP group). The mean BAI with minimum weightbearing in active TP group was significantly greater than that of non active TP group when more than 2,000 cyclic axial loadings were applied. After 10,000 cyclic axial loadings, the mean BAs with minimum weightbearing in active TP group and non active TP group were 0.258 ± 0.012 and 0.226 ± 0.011, respectively. (Figure 2)

The results of the BAI with maximal weightbearing were similar trend. The initial BAs with maximal weightbearing were 0.239 ± 0.009 (active TP group) and 0.239 ± 0.014 (non active TP group). The mean BAI of non active TP group decreased less than 0.21 after 3,000 cyclic axial loadings. On the other hand, the mean BAI of active TP group were remained over 0.21. After 10,000 cyclic axial loadings, the mean BAs with maximal weightbearing were 0.212 ± 0.011 (active TP group) and 0.196 ± 0.015 (non active TP group). Statistical significances were found between each group in the mean BAI with maximal weightbearing after 7,000 cyclic axial loadings. (Figure 3)

**DISCUSSION:**

We investigated the change of the arch height during cyclic axial loadings with or without tibialis posterior muscle force. The present results indicated that the BAI with active TP group was almost constant after 3,000 cyclic axial loadings. It suggests that the activated tibialis posterior muscle is important to maintain the medial longitudinal arch height. The plantar fascia, long and short plantar ligaments, and spring ligament are the most important static contributors to arch stability. The present results demonstrated that the arch height was not maintained with passive supports alone. In conclusion, the active effect of the tibialis posterior muscle was essential to support the medial longitudinal arch of the human foot.

**REFERENCES:**