2022 J. Leonard Goldner Award Winner: Passive Eversion Assessment for Progressive Collapsing Foot Deformity after Lateral Column Lengthening: A Cadaveric Biomechanical Study
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Introduction/Purpose: Lateral column lengthening (LCL) is an established procedure for progressive collapsing foot deformity (PCFD) patients. While functional improvements are often reported after LCL, increased post-surgical lateral foot pain, attributed to decreased subtalar joint motion, remains a concern. The optimal wedge size is determined intraoperatively by measuring passive eversion of the hindfoot to ensure adequate eversion motion and radiographic correction. However, it is unknown whether a subjective assessment of passive eversion is associated with objective postoperative measurements of foot stiffness, such as plantar pressure. Our goal was to quantify the relationship between eversion during a passive assessment and plantar pressures during simulations of level walking. We hypothesized that a strong relationship exists between the location of plantar pressure and the eversion measured with passive manipulation.

Methods: A deformity was created in ten mid-tibia cadaveric specimens (four female, age range: 35-72) by transecting the spring ligament and medial talonavicular joint capsule followed by cyclic loading. A six degrees-of-freedom robotic gait simulator was used to simulate the stance phase of level walking. Joint kinematics and plantar pressure data were collected during each simulation. A passive assessment of hindfoot eversion was then conducted manually by a fellowship-trained orthopaedic surgeon and recorded by the motion capture system. Five conditions were tested: intact, PCFD, and three LCL wedge conditions (4, 6, 8mm). Outcome measures for each condition included the lateral-to-medial forefoot plantar pressure ratio during walking simulations and the peak subtalar eversion measured during the assessment. A linear mixed effects model was used to determine the association between the plantar pressure and LCL wedge thickness. Pearson correlation coefficients were calculated to determine the relationship between subtalar eversion and plantar pressure.

Results: There was a significant relationship between the size of LCL wedge and the forefoot lateral-to-medial average pressure ratio (p<0.001). Every 2mm increase in LCL wedge size resulted in a 0.20 +- 0.03 increase in the LM ratio, indicating a significant lateral shift in plantar pressure with each increase in wedge size. The 4mm wedge was most effective in restoring plantar pressure and eversion to intact (Figure 1). The peak subtalar eversion measured during the assessment decreased with an increase in the size of the LCL wedge. A strong correlation (r(38)=0.51, p<0.01) was found between the LM ratio and the peak subtalar eversion. This indicates that a decrease in the eversion measured during passive assessment is strongly associated with a lateral shift in plantar pressure.

Conclusion: This study demonstrates that reduced eversion following LCL is associated with increased lateral plantar pressure which is consistent with stiffness and lateral plantar pain that is a well-known complication of this surgery. Passive eversion measurement is likely to help predict functional performance. The 4mm wedge best restored outcomes to normal, whereas larger wedges resulted in increased lateral loading and decreased eversion. A change in correction of 2mm made a significant difference in loss of eversion motion and minimizing the amount of lengthening is strongly recommended.
Figure 1: The peak subtalar eversion measured during passive assessment (green) and the lateral-to-medial average forefoot pressure ratio during walking simulations (purple) for each condition tested. A strong correlation was found between plantar pressure and the maximum subtalar eversion.