Three-Dimensional Distance and Coverage Maps in the Assessment of Peritalar Subluxation in Progressive Collapsing Foot Deformity

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Introduction/Purpose: Progressive collapsing foot deformity (PCFD), formerly termed Adult-Acquired Flatfoot Deformity (AAFDF), is a complex 3-dimensional (3D) deformity characterized by peritalar subluxation (PTS) of the hindfoot through the triple joint complex. PTS severity is typically measured at the posterior facet of the subtalar joint, but recent studies have called this into question and presented the middle facet as a more accurate marker of deformity. The objective of this study was to use 3D distance mapping (DM) from weightbearing computed tomography (WBCT) images to assess PTS in PCFD patients and controls across the entire peritalar surface. We hypothesized that 3D DMs would identify the middle facet as a superior marker for PTS, as well as indicate increased extra-articular sinus tarsi and subfibular impingements in PCFD patients.

Methods: In this case control study, we analyzed WBCT data of 20 consecutive patients with flexible PCFD and 10 controls. Novel 3D distance mapping (DM) technique was used to objectively characterize joint coverage across the entire peritalar surface, including both articular (anterior, middle and posterior facets of the subtalar joint) and nonarticular regions (sinus tarsi and subfibular areas). Distance maps were measured in millimeters, and colored to highlight regions of interest. Distances from 1-4mm were shown in blue to indicate expected joint interaction/extra-articular proximity, while distances under 1mm were highlighted in yellow/red indicating close bone proximity consistent with joint space narrowing (articular) or impingement (extra-articular). Joint coverage was defined as percentage of articular area with DMs <4 mm. Coverage Maps (CM) were built highlighting areas of adequate joint interaction (blue), joint subluxation (pink), and impingement (red). Comparisons were performed with independent t-tests or Wilcoxon tests. P values <.05 were considered significant.

Results: Overall, coverage was decreased in articular regions and impingement was increased in nonarticular regions of PCFD patients. Objectively, a significant 46.6% average increase in the uncoverage of the middle facet of the subtalar joint was observed in PCFD patients (p<.001), consistent with significant middle facet subluxation when compared to controls. No significant similar uncoverage was identified in the anterior or posterior facets. Extra-articularly, an overall 98% increase in sinus tarsi coverage was identified in PCFD patients (p<.007) with direct sinus tarsi impingement in 6 of 20 patients with PCFD, and one of the controls. Direct subfibular impingement was noted in only 1 of 20 PCFD patients, but subfibular space narrowing greater than 2 standard deviations was noted in 17 of 20 PCFD patients. Attached figures demonstrate examples of distance and coverage maps, as well as a comparative averaged assessment of peritalar surface coverage in PCFD and controls.

Conclusion: Our study results revealed that when compared to controls PCFD patients demonstrated that a significant decrease in 3D measures of subtalar joint coverage was only identified in the middle facet, but not at the anterior or posterior facets. We also determined significantly decreased inter-bone distances in the sinus tarsi and subfibular regions of PCFD patients, confirming the occurrence of extra-articular impingement in those areas. We hope that the use of these 3D accurate and objective measures of distance (DM) and coverage maps (CM) of middle facet subluxation will support early detection of PCFD patients at high risk for progressive collapse.

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Overall Peritalar Coverage (PCFD vs Controls)

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