

A NEW METHOD TO EVALUATE THE DEFORMITY OF THE TALAR DOME

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INTRODUCTION

A flat-top talar dome is a deformity that can occur after treatment of idiopathic clubfoot. It has been associated with altered ankle mobility [1]. The manual measure of radius to length (R/L ratio) of the talus is a common index of trochlear flattening which has limitations [1-5]. This study describes a new image-processing algorithm to quantify the deformity.

METHODS

Skeletally mature patients previously treated for idiopathic clubfoot were identified from an approved clubfoot registry. Participants without orthopedic conditions with foot radiographs were included as a control group. Weight bearing, lateral foot radiographs were assessed in all participants. Manual measures of the talus included the radius of curvature (ROC), length, height, R/L ratio, alpha angle, radius of the tibial plafond, and the ratio of the radii of the talar dome and tibial plafond (R/R ratio) [1-3]. A custom image-processing MATLAB code identified the talus from lateral radiographs. End-points of the articulating surface of the talus were selected manually, and the average slopes of anterior, central, and posterior regions of the talar dome were calculated. Flatness was determined as the variance in the slopes across the three regions. Lower variance indicated a flatter dome morphology.

In affected feet, inter-rater reliability (IRR) was determined for the MATLAB (3 raters) and manual (4 raters) measures of talar dome flatness. Spearman's rho was used to determine correlations between these measures of talar dome flatness.

Control foot radiographs demonstrating false rotational profiles were excluded (n=5 excluded). Average flatness of the talar dome of the clubfoot group, using both measurement methods, was compared to flatness of the control group using unpaired two-tailed student's t-tests.

Flatness measurements of the talar dome are presented using the radiographic technique and image processing technique in a skeletally mature patient previously treated for clubfoot, who had undergone 3D gait analysis as part of the registry.

RESULTS AND DISCUSSION

Inter-rater reliability (IRR) for all manual measures (n=52 affected feet) were moderate to excellent (ICC > 0.600). The IRR for the MATLAB measure of talar dome flatness (n=15 affected feet) was excellent (ICC=.895). Flatness of affected feet using MATLAB was strongly correlated with ROC of the talar dome (r=.621, p=.013), alpha angle (r=.557, p=.031), and R/R ratio (r=-.589, p=.021).

The average R/L ratio of control feet (n=27 feet; R/L ratio=.361±.021) was significantly different from that of affected feet (.561±.411; p =0.02). The average MATLAB flatness for the control and affected feet were .767±.156 and .372±.173, respectively, which were significantly different (p<0.001).

Lateral radiographs of the example clubfoot patient visually demonstrated unequal deformity (R>L) (Fig. 1). However, the R/L ratios were near equal (R=.407, L=.408). Other measures were similar between sides, but the R/R ratio was higher for the left foot, indicating more congruency in articulation (R=.784, L=.957). The MATLAB measure of flatness was lower for the right foot, quantifying a flatter talar dome (R=.370, L=.599). Max ankle power for each side was similar (R= 3.38 W/kg; L= 3.42 W/kg). However, the right ankle had a decreased dynamic range of motion (R= 33°; L= 37°).

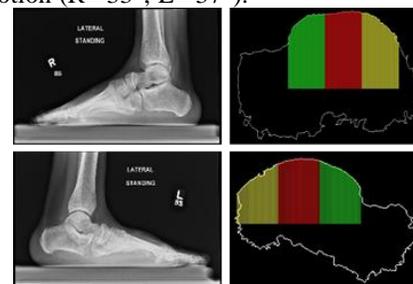


Figure 1: Standing lateral radiographs with MATLAB visual output (right) of a participant previously treated for bilateral clubfoot

The new method of flatness revealed a side to side difference that the traditional R/L ratio failed to show, and functionally, ankle mechanics reflected the differences in talar dome deformity between each side. Along with added insight demonstrated in this case, the method was highly reliable and quick to apply (<5 min per radiograph).

SIGNIFICANCE

The flat-top talus deformity may impact daily activities and has been associated with increased risk for arthrosis [6]. This custom-written image processing tool may provide additional insight into the morphology.

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