Correlation between Static Radiographic Measurements and Inter-segmental Angle Measurements During Gait Using a Multi-segment Foot Model with a 15-Marker Set

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Summary:
The static radiography cannot reflect the dynamic change of foot and ankle segments during gait. In this study, we purposed to evaluate the correlation between the static radiographic indices and the segmental foot motion indices measured by 3D multi-segment foot model (MFM) gait analysis. Generally, the segmental foot motion indices measured by 3D MFM gait analysis were well correlated with the static radiographic indices. We believe that a 3D MFM gait analysis is a reliable assessment tool for evaluation of segmental foot motions during gait.

Introduction:
A static radiographic examination of the musculoskeletal systems is the primary and most widely used evaluation method in the orthopedic clinics. However, the static radiography cannot reflect the dynamic change of foot and ankle segments during gait. For past two decades, the clinical application of 3D multi-segment foot model (MFM) has been increased. In this study, we purposed to evaluate the correlation between the static radiographic indices and the segmental foot motion indices measured by 3D MFM gait analysis.

Methods:
One hundred and twenty five female adults were tested by a 3D MFM gait analysis with 15-markers. The static weight bearing radiography taken in this study included lower extremity teleradiography, foot anteroposteiror (AP) and lateral view. The hallux valgus angle, 1st interphalangeal angle, AP talo-1st metatarsal angle, cavus ratio, calcaneal pitch, lateral talo-calcaneal angle, lateral talo-1st metatarsal angle (Meary angle), lateral calcaneo-1st metatarsal angle (Hibb angle), AP tibial plafond angle, and AP talo-tibial angle were calculated on radiography. In gait analysis, angular measurements of each segment (hallux, forefoot, Hindfoot, arch) of specific gait cycle (initial contact, mid-stance, toe-off, and mid-swing) was recorded. Pearson correlation coefficient was used for analysis of correlation.

Results:
The hallux valgus angle in static radiography was highly correlated with the transverse planar angle of the hallux segments in gait analysis. In subjects with higher hallux valgus angle, the arch index (p<0.001) and the range of motion in hallux sagittal plane (p=0.037) were decreased. The AP talo-1st metatarsal angle in radiography is related to forefoot rotation (p=0.016) during gait. The Meary angle in the radiography is correlated with the arch index (p=0.022) in gait analysis. The Meary angle also had a correlation with the sagittal range of motion (p<0.001) and the pronation in hindfoot (p<0.001). In this study, we could not
effectively evaluate the hindfoot alignment with radiography, thus could not show no significant correlation with the measurements from the gait analysis.

**Conclusion:**
Generally, the segmental foot motion indices measured by 3D MFM gait analysis were well correlated with the static radiographic indices. We believe that a 3D MFM gait analysis is a reliable assessment tool for evaluation of segmental foot motions during gait. However, further research should be necessary to define the clinical relevance of specific segmental motion, especially in the alignment and motion of hindfoot segment.