Development of a protocol to quantify in-vivo kinematics of the Foot and Ankle

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Abstract: 300 words

Skeletal kinematics are traditionally measured by motion analysis methods such as optical motion capture (OMC). While easy to carry out and clinically relevant for certain applications, it is not suitable for analysing the ankle joint due to its anatomical complexity and associated errors. A greater understanding of the function of healthy ankle joints could lead to an improvement in the success of ankle-replacement surgeries. Biplane video X-ray (BVX) is a technique that allows direct measurement of individual bones using highspeed, dynamic X-Rays.

Objectives

To develop a protocol to quantify in-vivo foot and ankle kinematics using a bespoke High-speed Dynamic Biplane X-ray system combined with OMC.

Methods

Two healthy volunteers performed five level gait and step-down trials while simultaneous BVX and synchronised OMC were captured. Volunteers undertook MR imaging (Magnetom 3T Prisma, Siemens) which was manually segmented into 3D bone models (Simpleware Scan IP, Synopsis). Bone position and orientation for the Talus, Tibia and Calcaneus were calculated by manual matching of 3D Bone models to X-Rays (DSX Suite, C-Motion, Inc.). OMC markers were tracked (QTM, Qualisys) and processed using Visual 3D (C-motion, Inc.).

Results

Initial results for level gait showed that OMC overestimated the rotational range of motion (ROM) in all three planes for the tibiotalar joint compared with BVX (Sagittal: OMC 30°/BVX 20°, Frontal : OMC 16°/BVX 15° and Transverse: OMC 20°/BVX 17°). Looking at the sagittal plane of the subtalar joint showed that OMC (22°) over-estimated the ROM compared with BVX (14°) and underestimated the ROM in the other planes (Frontal: OMC 8°/BVX 15° and Transverse: OMC 18°/BVX 20°).

Conclusions

The results highlight the discrepancy between OMC and BVX methods. However, the BVX results were like what has been seen in literature. The protocol developed here will form the foundation of future patient-based studies to investigate in-vivo ankle kinematics.