QUANTIFICATION OF PELVIC SOFT TISSUE ARTIFACT

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Introduction

Soft tissue artifact (STA) is one of the major obstacles faced in clinical motion analysis[1]. Few studies have been able to quantify the motion of the skin relative to the underlying bone[2] and an extensive literature search did not find any studies examining pelvic STA. This study uses markers mounted on pins inserted into the sacrum to track the relative motion of skin mounted markers on the pelvis.

Clinical Significance

STA is a major problem in clinical motion analysis. This study quantifies the STA at the pelvis for several subjects with no pathology.

Methods

IRB approval was granted and all subjects gave informed consent prior to undergoing any procedures. Each subject was given pre-procedure antibiotic prophylaxis. In the operating room, fluoroscopy was used to locate the spinous processes of the S1 vertebrae. Lidocaine with Epinephrine was used to anesthetize the skin and the periosteum. Next, 2 0.062” Kirshner wires were inserted into the spinous process. The two pins were clamped together to minimize the possibility of rotation about the pin axis. A rigid marker triad was attached to the pair of pins. Skin-mounted markers were then placed on the palpated ASIS and PSIS landmarks and their average position, relative to the sacral pin markers, during a standing static trial, were used to define virtual markers. The pin-mounted

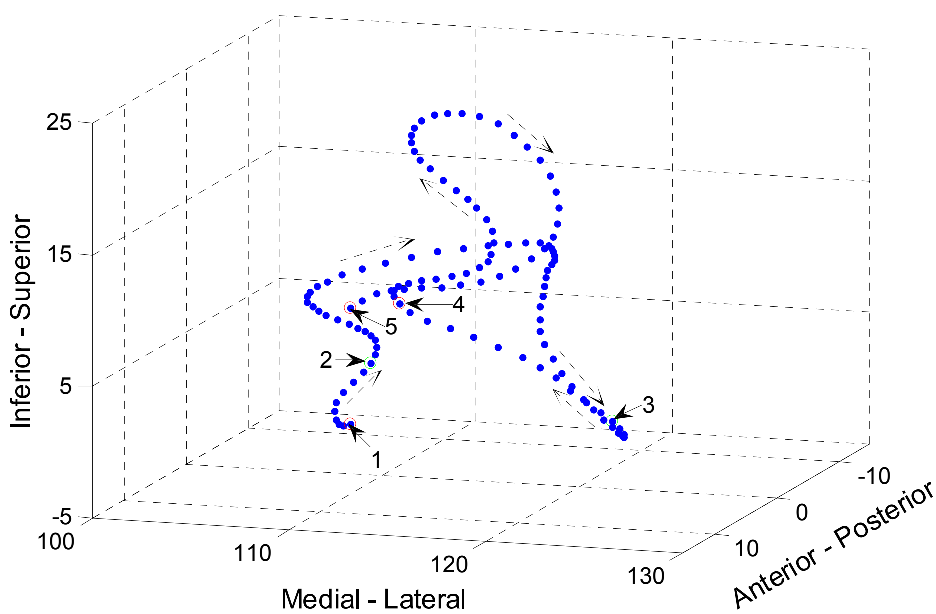

Figure 1. Skin motion artifact during a single walking cycle is shown**.** The movement of the physical ASIS marker is given relative to the pin-based pelvic coordinate system. The range of motion gives an estimate of the soft tissue artifact in millimeters. The numbers denote 1) foot strike, 2) opposite foot off, 3) opposite foot strike, 4) foot off, 5) foot strike. The dashed arrows show the progression of time.

markers were processed *via* the Procrustes method to enforce triad rigidity[3], followed by low pass filtering at 5 Hz. The virtual markers were then used to create a virtual pelvic coordinate system rigidly attached to the sacrum. The motions of the skin-mounted ASIS and PSIS markers were transformed into the rigid virtual pelvic frame and then decomposed into each of the anatomical reference directions defined by the x-y-z directions of the rigid virtual pelvic coordinate system.

Results

Resulting skin-mounted marker ranges showed significant soft tissue artifact (Figures 1-2). Note that if no soft tissue artifact were present, the range would be 0.0!

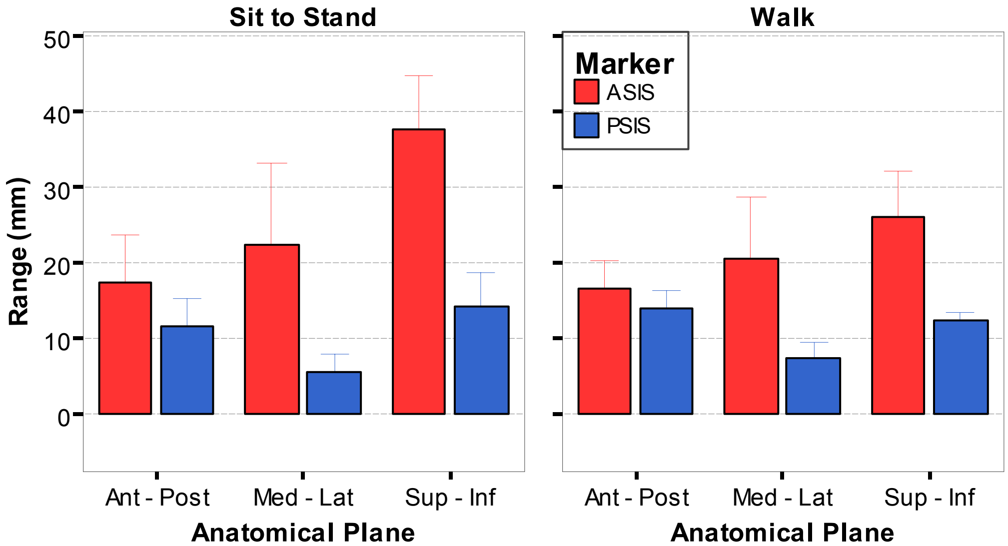

Figure 2 Average and the 95% confidence interval for the range of soft tissue motion in each plane for the PSIS and ASIS markers. Significant STA is observed for both sit-to-stand and walking.

Discussion

This appears to be the first study to quantify soft tissue artifact at the pelvis. Significant STA was measured at the pelvis - more than 35 mm in some cases. The ASIS markers exhibited more STA than the PSIS markers, especially in the superior-inferior direction. In a previous studies, Cappozzo found STA at the greater trochanter of up to 30 mm,[4] while Stagni *et al*. found STA on the order of 30 mm at the proximal femur[2]. Clearly the STA problem at the pelvis is as big, if not bigger, than at the femur. Possible sources of error in this study include bending of the sacral pins and motion in the sacroiliac joint. However, the magnitudes of these effects, if they existed, would be small compared to the magnitude of the STA[5]. Further analyses will attempt to correlate the artifact to specific motions of the hips and pelvis, determine the exact consequences of the artifact on kinematics at the pelvis, and track error propagation down the kinematic chain (*i.e.* at the hips, knees and ankles).

References

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