AN INVESTIGATION OF SOFT TISSUE ARTIFACT DURING WALKING:
TRANSLATION AND ROTATION OF SKIN MARKERS

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INTRODUCTION

Soft tissue artifact (STA), caused by movement of muscle and skin with respect to the bone underneath, has been proved to be a major source of error when the optoelectronic stereophotogrammetry technique is used in body movement studies (Alberto et al., 2005). Most previous studies of STA focused on skin-marker translation but did not consider marker rotation. However, a marker is normally more than 10 mm over the skin and attached to an area greater than 3 cm². The marker has a rotational movement relative to the bone’s coordinate system. Consideration of this rotational component of STA is essential when using marker rigid-arrays (such as marker pairs or marker triads) because these rigid-arrays can reduce the translation component of STA but cannot reduce the rotation component.

Although STA is considered as a subject-dependent artifact, we hypothesize that STA is also joint movement-dependent. In this study both translation and rotation of skin markers during walking were investigated.

METHODS

Eight subjects (5 males and 3 females) were tested during level walking using an IRB approved protocol. An 11-camera motion analysis system was used (Motion Analysis Co., CA). Seven single markers and 4 marker-triads were placed on both thighs; 6 single markers and 4 marker-triads were put on the shanks. Their positions are shown in Fig.1. Marker-triads had same attaching areas as single markers so their center points could also sever as single markers.

RESULTS AND DISCUSSION

The translation and rotation of each marker or triad on the 16 legs during walking were analyzed. We found that subject-independent patterns of translation and/or rotation could be identified easily for each marker or triad. As an example, Fig.2 shows the means and standard deviations of triad T1’s translation and rotation (N=16). The translation and rotation of STA were
dependent on the adjacent joint positions (position in gait cycle). However, there were significant difference of translation and/or rotation among markers and/or triads (p<0.01).

**Fig.2** Means (SD) of triad T1’s translation and rotation.

Figure 2 shows the three rotations of each triad. Rotations could be up to 10 degrees for the thigh triads. Overall, the markers on the thigh had greater translation and rotation STA (p<0.01).

**Fig.4** Triads’ rotation. From left to right: valgus/varus, flexion/extension, external/internal rotation.

**CONCLUSIONS**

Though STA is often considered subject-dependent, our study shows both translation and rotation of skin markers were location-specific and related to the adjacent joint angles. The patterns of STA translation and rotation were similar for each subject. Thigh markers had greater translation and rotation STA than shank markers. The translation STA had similar values with smaller standard deviations when comparing with published data. Markers’ rotational STA are reported here for the first time and the results suggest that rotational STA can not be removed or reduced by using extended wand markers or marker rigid-arrays normally used to calculate the rotations of a segment and joint.

**REFERENCES**

