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Quantification of the soft tissue artifacts of the upper limb during movements

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Introduction: The upper limbs are essential for daily activities, and their functional performances are often evaluated using skin marker-based motion analysis. The measured kinematics of the upper limb is often affected by errors associated with the marker movements relative to the underlying bone, called soft tissue artifacts (STA), which are difficult to eliminate noninvasively. Quantification the STA of the upper limb during activities will be helpful for better choice of marker placement and for development of mathematical methods in reducing STA, which was the purpose of the current study.

Methods: Six healthy adults were attached with 24 retro-reflective markers on the upper arm (9 technical markers: UA1-UA9; humerus epicondyles: LE, ME), and forearm (9 technical markers: FA1-FA9; olecranon: OLE; radius head: RH; radial styloid: RS; ulnar styloid: US). Each subject performed whole ranges of elbow flexion/extension (F/E) and forearm pronation/supination (P/S) under the simultaneous surveillance of a motion capture system and a fluoroscopy system. The subjects also received CT scans so that the motions of the humerus, radius and ulna were accurately determined using a novel fluoroscopy-to-CT registration approach. The STA of the markers were then calculated as the marker movement relative to the underlying bone.

Results and Discussion: During F/E, markers around the elbow showed the largest STA (RH: 15.5, LE: 21.1, ME: 26.2, unit: mm) while markers away from the elbow showed the smallest STA (UA1: 8.0, RS: 4.6, US: 4.8, unit: mm). During P/S, upper arm markers near the elbow and forearm markers away from the elbow showed the smallest STA (UA3: 9.7, UA9: 9.7, US: 8.0, RS: 9.0, unit: mm) while the largest STA were found at FA1 (29.9) and FA7 (30.3). The current results indicate the marker positions with less STA for future kinematic measurements of the upper limbs during activities.

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A biophysically-based tissue model for optimizing gastric pacing

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Gastric pacing has been investigated for modulating gastric motility in diseased states. However, to advance this field, new pacing protocols are needed that directly improve gastric motility while increasing the efficiency of existing pacing devices. This study presents a mathematical tissue model for investigating slow wave entrainment during pacing, its comparison with experimental data gathered by high-resolution electrical mapping. The model was used to predict the effect anisotropic conductivities on slow wave entrainment, and the effect of gastric pacing on ectopic dysrhythmias. A diffusion based slow wave propagation model was used, with cell activity modeled as a finite-state machine. Initially, normal slow-wave antegrade propagation was modeled in accordance with experimental data. Then, these simulation parameters were applied to compare the model, in tandem with experimental studies in which an external pacing signal entrains native slow wave activity. The effect of different pacing frequencies on entrainment was demonstrated. Finally, this model was also used for simulating the effect of external stimuli for entraining a distal ectopic focal pacemaker. Two cases were studied with different fiber directions. The results showed that the pacing frequency and orientation of the fibers relative to the stimulation and ectopic site plays a critical role in gastric pacing efficacy.