

COMPARISON BETWEEN TRIPOD AND SKIN FIXED RECORDING OF SCAPULAR MOTION

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INTRODUCTION

To record 3D scapular rotation, we currently use a scapula-locator: a tripod with an electromagnetic receiver mounted on it, which has to be placed manually and repetitively over the scapula during static humeral elevations. Measurements of scapular motion by means of an electromagnetic receiver fixed onto the flat part of the acromion (=skin fixed method) potentially enables dynamic and fast motion recording, making it very suitable for clinical measurements. This study was undertaken to: 1) compare tripod to skin fixed recording (concurrent validity); 2) determine the inter-observer variability of skin fixed recording; 3) determine the intra-trial variability; 4) compare static versus dynamical measurements of scapular rotation at moderate speed.

METHODS

3D shoulder kinematical recordings were performed at eight healthy subjects using both an electromagnetic receiver fixed to an adjustable tripod [1,2] and a receiver fixed to the flat part of the acromion. Measurements were performed according to the standard of the International Shoulder Group [3]. Scapular rotation of the right shoulder was measured during symmetrical elevation in frontal and sagittal plane respectively. Measurements were performed by three observers. Measurements of scapular rotation were performed repetitively to full maximal elevation. Interpolation of data of each of the three scapular rotations (pro-retraction, latero-rotation and spinal tilt) was performed using p-splines [4]. Sampled data at 30, 50, 70, 90, 110 and 130° of humeral elevation were used for statistical testing using a GLM-ANOVA with repeated measurements (SPSS 11.0) to establish the difference between tripod- and skin fixed recordings, intra-trial variability and inter-observer variability of skin fixed measurements and to assess the difference between static and dynamical (cyclic elevation at about 0.5 Hz) measurements of scapular orientation using the skin fixed method.

RESULTS AND DISCUSSION

The skin fixed method underestimated scapular rotations compared to tripod-based measurements. We found a maximal difference of 6° for orientation (=offset) and 7° for rotation regarding scapula latero rotation during elevation in the frontal plane. These errors exceed the expected error of about 2° evolving from palpation inaccuracies [5] and are attributed to: 1) differences in definitions of local co-ordinate systems (offset error); 2) palpation variability (offset error); 3) skin motion relative to bone (rotational error); 4) influence on acromion receiver position by a stiff receiver cable (rotational error) and 5) interposition of *m. deltoideus* between acromion receiver and scapular bone (rotational error). Inter-observer

variability was low compared to tripod measurements (1.91°-4.95° vs. 4.35°-5.15°) and inter trial reliability was high (intra class correlation coefficient > 0.84). The RMSE of static versus dynamical measurements was below 1°.

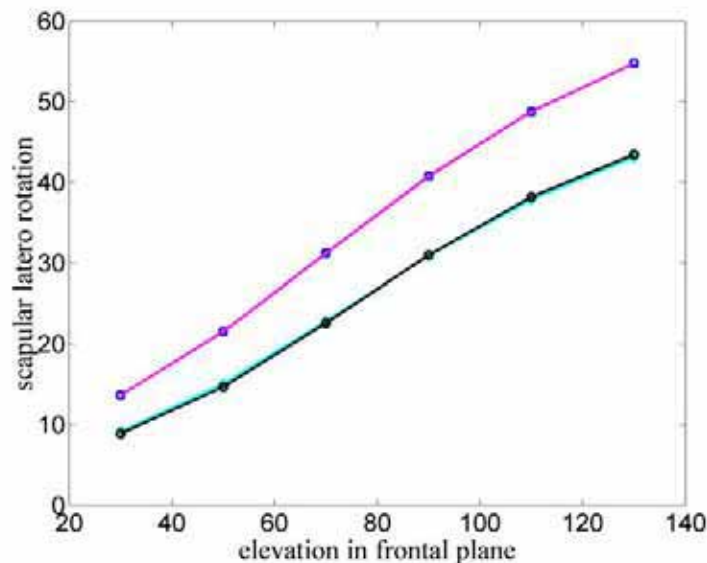


Figure 1: scapular latero rotation as measured by means of a tripod (□) and a skin-fixed method, both statically (Δ) and dynamically (o)

CONCLUSION

A skin fixed method to record scapular rotations is precise but less accurate compared to tripod measurements. Advantages over the latter method are a lower inter-observer variability and the possibility to record scapular motion during low speed continuous arm elevations. Based on the current data, considering a maximal rotational error of 7°, we conclude that shoulder kinematical measurements in a clinical setting can be performed using an electromagnetic receiver attached to the flat part of the acromion.

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