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Short communication

Skin-fixed scapula trackers: A comparison of two dynamic methods across a range of calibration positions

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ABSTRACT

The aim of this study was to establish the optimal methodology for skin-fixed measurement of the scapula during dynamic movement. This was achieved by comparing an optimally positioned Scapula Tracker device (ST) to a previously described palpation device, taken as the true measure of scapular kinematics. These measurements were compared across a range of calibration positions, including the use of multiple calibration positions for a single movement, in order to establish an optimal calibration approach. Ten subjects' scapular motion was measured using this ST and a previously described Acromial Method (AM). The two datasets were compared at a standard, an optimal and a 'multiple' calibration position, thus allowing a direct comparison between two common skin-fixed methods to track the bony kinematics of the scapula across different calibration positions. A comparison was also made with a bone-fixed technique from the literature. At both the standard and optimal calibration positions the ST was shown to be the more accurate measure of internal rotation and posterior tilt, particularly above 100° of humerothoracic elevation. The ST errors were found to be acceptable in relation to clinically important levels. Calibration positions have been shown to have a significant effect on the errors of both skin-fixed measurement techniques and therefore the importance of correct calibration is highlighted. It has thus been shown that a ST can be used to accurately quantify scapular motion when appropriately calibrated for the range of motion being measured.

1. Introduction

Measuring the 3D kinematics of the scapula during dynamic movement provides important information for the diagnosis and treatments of clinical disorders (Fayad et al., 2008; Ludewig and Reynolds, 2009; Solem-Bertoft et al., 1993), rehabilitation techniques (Michener et al., 2004), sports performance (Meyer et al., 2008) and injury prevention (Bell-Jenje and Gray, 2005; Kibler and Sciascia, 2010; Prinold and Bull, 2010). However, the thick layer of soft tissue covering the scapula leads to movement artefacts of about 5° below 120° humerothoracic elevation and far greater above in surface measurement techniques (Karduna et al., 2001; Matsui et al., 2006). Palpation helps overcome skin artefacts but is impractical for dynamic movements or those that explore a large range of motion (e.g. athletic activities) (de Groot, 1997; Johnson et al., 1993; Meskers et al., 1998). However, palpation methods have recently been extended to slow movements, and the addition of pressure sensors on the Palpator (Fig. 1) feet shown to improve repeatability (Shaheen et al., 2011b). Invasive methods such as bone pins (Karduna et al., 2001) allow accurate measurement in a dynamic movement but are impractical for the wider population.

Of the two skin-fixed methods presented in the literature, the Scapula Tracker (ST) has greater accuracy than the Acromial Method (AM) (Fig. 1) (Karduna et al., 2001). However, a more recent paper has shown that the position of the AM can be optimised (Shaheen et al., 2011a) and therefore a comparison between the ST and AM at the optimal positions is required. In addition to the position of attachment, the position of calibration can theoretically influence measurement accuracy (Cappello et al., 2005). Therefore the aim of this study is to compare the ST and AM at an optimal fixation position and across a range of calibration positions during a dynamic activity.

2. Methods

2.1. Subjects

Ten healthy male subjects with no history of shoulder pathology participated in the study (age=27±4 years). Informed consent was obtained from each subject.

2.2. Measurements

Kinematic data was collected using a 10-camera optical motion tracking system (Vicon) at 200 Hz.

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