J Shoulder Elbow Surg (2014) 23, 1296-1300

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Accuracy and reliability testing of two methods to measure internal rotation of the glenohumeral joint

Justin M. Hall, MD, Frederick M. Azar, MD, Robert H. Miller III, MD, Richard Smith, PhD, Thomas W. Throckmorton, MD*

Department of Orthopaedic Surgery and Biomedical Engineering, University of Tennessee–Campbell Clinic, Memphis, TN, USA

Background: We compared accuracy and reliability of a traditional method of measurement (most cephalad vertebral spinous process that can be reached by a patient with the extended thumb) to estimates made with the shoulder in abduction to determine if there were differences between the two methods.

Methods: Six physicians with fellowship training in sports medicine or shoulder surgery estimated measurements in 48 healthy volunteers. Three were randomly chosen to make estimates of both internal rotation measurements for each volunteer. An independent observer made objective measurements on lateral scoliosis films (spinous process method) or with a goniometer (abduction method). Examiners were blinded to objective measurements as well as to previous estimates.

Results: Intraclass coefficients for interobserver reliability for the traditional method averaged 0.75, indicating good agreement among observers. The difference in vertebral level estimated by the examiner and the actual radiographic level averaged 1.8 levels. The intraclass coefficient for interobserver reliability for the abduction method averaged 0.81 for all examiners, indicating near-perfect agreement. Confidence intervals indicated that estimates were an average of 8° different from the objective goniometer measurements. Pearson correlation coefficients of intraobserver reliability for the abduction method averaged 0.94, indicating near-perfect agreement within observers. Confidence intervals demonstrated repeated estimates between 5° and 10° of the original.

Conclusions: Internal rotation estimates made with the shoulder abducted demonstrated interobserver reliability superior to that of spinous process estimates, and reproducibility was high. On the basis of this finding, we now take glenohumeral internal rotation measurements with the shoulder in abduction and use a goniometer to maximize accuracy and objectivity.

Level of evidence: Level III, Diagnostic Study.

Keywords: Glenohumeral joint; internal rotation; measurement; spinous process method; abduction method; accuracy

Internal rotation of the glenohumeral joint is an important part of the clinical examination of the shoulder, reflecting an ability to perform several activities of daily living including self-care.[9] Several shoulder outcomes measures use glenohumeral internal rotation as part of their

This study was approved by the Institutional Review Board of the University of Tennessee Health Science Center.

*Reprint requests: Thomas W. Throckmorton, MD, 1211 Union Avenue, Suite 510, Memphis, TN 38104, USA.

E-mail address: tthrockmorton@campbellclinic.com (T.W. Throckmorton).

1058-2746/$ - see front matter © 2014 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2013.12.015

assessment,[4,15] and clinical studies often use this measurement as part of the outcomes evaluation.[8,11,19] Glenohumeral internal rotation is most commonly reported as the most cephalad vertebral spinous process that can be reached by a patient with his or her extended thumb.[6] This method has been shown to have poor interobserver reliability and only good intraobserver reliability.[6,18] In addition, this traditional method can easily be skewed by abnormal anatomy and limited or increased motion of the elbow and scapulothoracic articulation.[18]

Measurement of internal rotation of the glenohumeral joint with goniometers or inclinometers with the shoulder in 90° of abduction and the elbow flexed to 90° has been shown to have good interobserver and intraobserver reliability.[1,12,13] Scapulothoracic motion has been shown to contribute up to approximately 12% to the measured internal rotation of the shoulder.[10] Boon and Smith[3] determined that a more accurate assessment of true glenohumeral internal rotation can be made when the scapula is manually stabilized by the examiner and the shoulder is in 90° of abduction.

Although spinous process estimation has been proved to be unreliable,[6,18] it is still the most commonly used method to report internal rotation of the glenohumeral joint. No studies to date have compared this method with measurements taken with the shoulder in abduction. The purpose of this study was to compare the accuracy and reliability of the traditional spinous process estimation method to estimates of measurements taken in abduction. We hypothesized that there would be no significant differences in reliability or accuracy between the two methods.

Materials and methods

This prospective comparative study recruited 61 healthy volunteers between 18 and 65 years of age. Excluded were women of childbearing age, patients with previous shoulder surgery, and those with current shoulder pain. Women of childbearing age were excluded because of the radiation from the lateral scoliosis view taken of each patient as a part of the study. Patients with elbow pain or prior elbow surgery also were excluded because elbow range of motion has been shown to affect spinous process estimates.[14] Thirteen patients were excluded because of poor-quality radiographs, leaving a total of 48 subjects, 38 men and 10 women.

Six physicians with fellowship-level training in sports medicine or shoulder and elbow surgery composed a pool of observers to estimate measurements. All examiners were familiar with both internal rotation measurement techniques. For each patient in the study, 3 of the 6 physicians were randomly chosen to make estimates of both internal rotation measurements.

The side examined was chosen at random by an independent observer (27 right and 21 left). The traditional spinous process estimation method was used first. After a small radiopaque metal sphere was taped to the tip of the thumb, the volunteer's shoulder was internally rotated and the thumb was placed at a random midline location on the back by the independent observer (Fig. 1). Each of the 3 examiners then recorded his estimate of the vertebral level at which the tip of the volunteer's thumb was located. With the patient in this position, a lateral scoliosis film was taken, and the actual vertebral spinous process closest to the metal sphere was recorded by the independent observer (Fig. 2).

Figure 1 Measurement of internal rotation by traditional spinous process estimation. A radiopaque marker was taped to the subject's thumb, the shoulder was internally rotated, and the thumb was placed at a random midline location.

For the abduction method, the same, previously examined shoulder was placed by the independent observer in 90° of abduction, and with the scapula stabilized, the arm was internally rotated to a random point between 0° and 90° of rotation. The independent observer then used a standard goniometer to measure the angle between horizontal and the axis of the volunteer's forearm and recorded this measurement (Fig. 3). With the goniometer removed, the 3 examiners then recorded their estimates of internal rotation. This process was repeated for each patient after an interval of at least 10 minutes, after which the independent observer placed the volunteer's shoulder back in its initial internal rotation using the goniometer as a guide, and the 3 examiners again estimated the internal rotation of the glenohumeral joint. All data were collected by the independent observer. The examiners were blinded to goniometric measurements as well as to their previous estimates.

Statistical analyses for interobserver agreement were conducted for both methods by the two-tailed Pearson correlation coefficient for intraclass correlation with 95% confidence intervals. Statistical analysis for intraobserver reliability also was performed for the abduction/internal rotation method by the Spearman correlation coefficient to find intraclass correlation with 95% confidence intervals. Intraclass coefficients of 0.6 to 0.8 were