PALPATION OF HUMERAL TUBEROSITIES CAN BE USED TO QUANTIFY THE HUMERAL RETROVERSION ANGLE

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SUMMARY
The magnitude of humeral retroversion affects the internal and external rotation range of shoulder joint. Bicipital- Forearm angle (BFA) is a measure of humeral retroversion. We compared the values of bicipital- forearm angle (BFA) between two methods. First method used palpation to position the humerus and second method employed real time ultrasound (US) imaging considered a standard for quantifying BFA. The results show that the positioning the humerus by manual palpation of the tuberosities is a valid way of quantifying the BFA and may be used in clinics and in laboratories.

INTRODUCTION
The internal rotation (IR) and external rotation (ER) range of motion (ROM) of shoulder joint can be influenced by three anatomic variables: the length of posterior capsule, the length of posterior muscles and the angle of humeral retroversion (HRA) [1, 3]. HRA is the acute angle formed medially and posteriorly between the trans-condylar axis (distal) of humerus and the line bisecting the humeral head (proximal) [4, 5]. An increase in the HRA leads to increased ER and reduced IR. These changes in ER and IR are also seen if the posterior capsule or the posterior muscles of the shoulder joint are shortened. The increased ER permits an overhead athlete to accelerate the arm over a greater arc of motion before the ball is released imparting it peak velocities.

Real time ultrasound (US) imaging has been used to quantify the HRA by quantifying the bicipital- forearm angle (BFA) [5]. BFA is the angle which the forearm forms with vertical with the elbow flexed to 90° (Figure 1). The BFA is inversely related to HRA i.e. the larger the magnitude of BFA the smaller the HRA [5]. Although, US imaging is the present gold standard for quantifying the BFA, they are not typically a part of PT clinics in US and in countries with growing economies. Additionally, PT’s cannot prescribe US imaging due to practice guidelines and even if they do it delays the assessment process as the patient may be referred elsewhere. On the other hand, palpation of various anatomical structures is a skill which can be learned, does not require access to any modality and can be utilized not only in clinics but also in various laboratories by individuals studying the shoulder joint. Thus the purpose of the study was to explore the possibility of using palpation of humeral tuberosities to orient humerus for quantifying the HRA. We hypothesized that the BFA values detected by manual palpation will be the same or will vary systematically with the BFA values detected by real time US imaging.

METHODS
Two testers performed the measurements; tester 1 used either the manual method of palpation or the real time US image to orient the humeral head while tester 2 quantified the BFA for every subject by a standard goniometer. Tester 1 was blinded to the angle and the orientation of the forearm by a curtain.

Palpation: Tester 1 began by palpating the lateral tip of acromian with his thumb pointed inferiorly and glided the thumb inferiorly between the anterior and middle fibers of deltoid, to the head of humerus. It was sometimes helpful to ask the subject to isometrically contract the deltoid in order to detect the interval between the anterior and middle fibers. Next, tester 1 palpated the lesser and the greater tuberosity of the humerus. At this point the orientation of the palpating thumb was changed from inferior to medial. The arm of the subject was rotated medially and laterally to palpate the

![Figure 1: the Bicipital - Forearm angle](Image)

Clinical assessments available now cannot differentiate between the three anatomical structures responsible for the change in ROM. This may often lead to misdirected treatment of the posterior tissues of the shoulder joint. First, incorrectly stretching the posterior capsule or posterior muscles to increase the IR ROM may lead to posterior instability at the shoulder joint. Second, the quantification of the HRA will help in selecting the appropriate subjects for studies exploring the effects of interventions focused on shoulder joint.
tuberosities. Humerus was considered in its desired orientation when the examiner felt the lesser and greater tuberosity under the pad of his thumb.

**Ultrasound:** A sonosite TITAN US machine was used to visualize the proximal humerus. Tester 1 oriented the US probe to get a transverse section of the proximal humerus. The position of the transducer of the US was fixed by a custom made holder and the orientation of the transducer was maintained by two bubble levels attached to it. The arm of the subject was rotated till humerus was in the desired orientation. The desired orientation of the humerus was defined as: the floor of the bicipital groove is horizontal and the greater and the lesser tuberosities at the same level on the US image [4]. A grid drawn on a transparency was attached on the screen of the US unit for consistently reproducing above criteria.

**RESULTS AND DISCUSSION**

Data was collected on 5 subjects (9 shoulders) mean age 29.75 years. All the subjects were right hand dominant and had no history of shoulder injury or of participation in overhead sports. The mean BFA detected by the standard method of real time US imagining and the palpation were 25.95° and 24.70° respectively. To assess the validity of the manual method, the intraclass correlation coefficient (ICC) (3,k) among the two methods i.e. palpation and real time US was calculated. A repeated measure ANOVA was performed (NCSS 2001) with the BFA as the main dependent variable and the manual method and US imaging as the independent variables. The ICC (3,k) was manually calculated using the equation

\[ \text{ICC} = \frac{\text{BMS} - \text{EMS}}{\text{BMS}} \]

Where BMS= between subject mean square and EMS= error mean square The ICC = 0.92. ICC values above 0.75 conventionally indicate good reliability between two raters. The parson’s correlation coefficient (r) among the BFA values detected by the two methods was 0.77. (Figure 2)

We quantified the values of the BFA using manual palpation to position the humeral head and compared it to the BFA values quantified using a real time US image. Use of palpation to orient the humerus for quantifying the BFA has several advantages over using the real time US imaging. First, US imaging units are not widely available across the outpatient clinics and even more so in less developed parts of the world. Second, even in places where a US unit is available the limitation arises as not all PT’s and researchers are trained for using US as an imaging modality. PT’s are however, trained for palpation and use this skill during the clinical assessment of a patient. Furthermore, these skills can be learned relatively easily by anyone. Third, referral of the patients for imaging often delays the assessment. Fourth, practice guidelines seldom permit a PT to prescribe a radiological evaluation.

Using palpation of humeral tuberosities to position the humerus may not be restricted to clinical practice. This method and skill set can be developed by researchers with a non clinical background with practice and basic knowledge of anatomy.

Present results are based on a small sample and we aim to recruit 20 subjects to reach adequate power for the study. If the current findings are retained in a larger sample, our next step will be to test inter- rater reliability of the palpation method.

![Figure 2: Scatter plot showing the relationship of the BFA quantified by real time US (vertical) and the BFA quantified by palpation (horizontal). r = 0.77.](image)

**CONCLUSIONS**

Use of palpation to position the humeral head for quantifying the HRA is as efficient as the use of real time US imaging. The results of the study suggest that manually palpating the humeral tuberosities to orient the humerus can be used in clinics and labs as a way to assess the HR angles. Future studies will aim to assess inter- rater reliability of the palpation method.

**REFERENCES**