Reliability of the posterolateral corner of the acromion as a landmark for the posterior arthroscopic portal of the shoulder

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**Hypothesis:** The present study aimed to evaluate the variability of the posterolateral corner of the acromion (PCA) position in relation to the glenohumeral joint, in a craniocaudal direction, to assess whether the universal use of a certain distance from that point will always lead to a consistent placement of the posterior arthroscopic portal of the shoulder.

**Methods:** The study used 140 dried scapulae (36 women and 34 men). Measurements included the glenoid height and the perpendicular distance between the PCA and the most superior point of the glenoid. The percentage of coverage of the glenoid by the acromion was defined as the ratio between the 2 measurements. The Student $t$ test was used to examine for significant differences between the sexes and the Student paired $t$ test between sides ($P < .05$).

**Results:** The average glenoid height was $3.37 \pm 0.29$ cm (range, 2.69-4.00 cm). The perpendicular distance between the PCA and the most superior point of the glenoid was $0.82 \pm 0.69$ cm (range, $-0.35$ to 2.27 cm). The percentage of coverage of the glenoid by the acromion was $24\% \pm 20\%$ (range, $-10\%$ to $64\%$).

**Conclusions:** The position of the PCA in relation to the glenohumeral joint is quite variable. Therefore, the use of a universal distance from the PCA will not always lead to a consistent placement of the posterior arthroscopic portal of the shoulder. Future research is needed in this area to develop techniques to individualize placement of the posterior portal.

**Level of evidence:** Anatomy Study, Cadaver Materials.

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**Keywords:** Shoulder arthroscopy; arthroscopic portals; anatomic landmarks; acromion; glenoid

Investigational Review Board approval was not required for this study.

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Accurate and safe positioning of arthroscopic portals is crucial for the success of each arthroscopic procedure. Accurate portal placement allows the surgeon to clearly see the surgical zone and provides the work angle and the range of motion required. A slight portal malpositioning could compromise operative success. Burkhart et al\textsuperscript{2}

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characteristically mentioned “improper portal position can frustrate the arthroscopist for the entire duration of the case…” The term “safe arthroscopic portal positioning” refers to the avoidance of iatrogenic injuries to periarticular neurovascular structures or intra-articular anatomic structures, which may lead to postoperative complications.

The posterior portal is the standard viewing portal for shoulder arthroscopy.3,4,9 The entry point is usually traced using the posterolateral corner of the acromion (PCA) as a landmark, specifically 2 cm below and 1 cm medial to that point. Other authors have suggested that using these landmarks may not lead to the ideal posterior portal placement and suggest using alternative measurements as guidelines.7

There are 2 basic prerequisites for using the PCA as a landmark for the posterior portal of the shoulder when measuring a universal certain distance from the landmark to the entry point. First, the PCA should be easily palpable, and second, it should have a constant anatomic relationship with the glenohumeral joint. Although there is no doubt about the subcutaneous location of the PCA, different guidelines from experienced arthroscopists, along with the great variability of the acromion geometry, motivated the present study.5,6 The purpose of this study was to evaluate the position of the PCA in relation to the glenohumeral joint, in a craniocaudal direction. Our hypothesis is that the PCA does not have a constant anatomic relationship with the glenohumeral joint, and therefore, the universal use of a certain distance from that point will not always lead to a consistent placement of the posterior arthroscopic portal of the shoulder.

Materials and methods

The study used 140 paired dried scapulae, 70 right and 70 left. The bones came from 70 donors (36 females and 34 males), which were kept in the public ossuaries. The donors were a mean age of 68.5 ± 10.72 years (range, 46-96 years). Scapulae with evidence of fracture, postmortem damage, or arthritis, which would prevent accurate measurements, were excluded, together with the scapula from the other side of the skeleton.

Each scapula was secured in a jig, onto a table. Two measurements were performed, and the ratio between them was calculated (Fig. 1). The height of the glenoid fossa (AB) was defined as the distance between the most superior and the most inferior point of the glenoid fossa and was drawn on the bone. The PCA was chosen as the point where the lateral rim of the acromion presented an abrupt change of direction, from anteroposterior to medial (C). A triangular ruler was placed, having 1 limb tangential to the glenoid height and another limb tangential to the posterolateral corner of the acromion. The intersection point was noted (D), and the distance between that point and the most superior point of the glenoid (A) was defined as the perpendicular distance between the posterolateral corner of the acromion and the most superior point of the glenoid fossa (AD). The ratio of the perpendicular distance between the posterolateral corner of the acromion and the most superior point of the glenoid (AD), to the height of the glenoid (AB) was defined as the percentage of coverage of the glenoid fossa by the acromion (AD/AB).

All bone measurements were done by the same investigator with a digital caliper with a resolution of 0.001 cm (Mitutoyo Company, Kanagawa, Japan). Each measurement was performed twice to calculate the intraobserver reliability, and the average of 2 measurements was recorded as a data point. Three of the authors (T.T., K.N., and G.P.) did both of the measurements independently and blinded in 20 scapulae, which were randomly chosen, to calculate the interobserver reliability. Measurements were rounded to 2 decimal places.

The intraobserver and interobserver reliability were assessed by the intraclass correlation coefficient (ICCs), 2-way mixed with absolute agreement and their 95% confidence intervals (CIs). All analyses were conducted using SPSS 19.9 software (SPSS Inc, Chicago, IL, USA). The Student t test was used to examine for significant differences between the sexes, and the Student paired t test was used for the 2 sides of the body. A P value of <.05 was considered statistically significant.

Results

The average height of the glenoid fossa was 3.37 ± 0.29 cm (range, 2.69-4.00 cm). It was significantly higher in men
than in women ($P < .001$) and on the right side than on the left side ($P = .001$). Intraobserver reliability was 0.974 (range, 0.964-0.981), and interobserver reliability was 0.937 (range, 0.874-0.972).

The mean distance between the PCA and the most superior point of the glenoid fossa was 0.82 ± 0.69 cm (range, −0.35 to 2.27 cm; Figs. 2 and 3). No significant difference was encountered between the sexes ($P = .813$) or between the left and the right scapulae ($P = .585$). Intraobserver reliability was 0.958 (range, 0.942-0.970), and interobserver reliability was 0.932 (range, 0.860-0.970).

The average percentage of coverage of the glenoid fossa by the acromion was 24% ± 20% (range, −10% to 64%). No significant difference was found between the sexes ($P = .791$) or between the sides of the body ($P = .817$). Results and statistical analysis are summarized in Tables I, II, and III.

**Discussion**

The present study measured the height of the glenoid fossa and the perpendicular distance between the PCA and the most superior point of the glenoid in a sample of dried scapulae. From the ratio between these 2 measurements, the percentage of coverage of the glenoid fossa by the acromion was calculated for each bone. The percentage provides a more definite picture of how low the PCA is located in relation to the glenohumeral joint. Statistically
significant differences, between sexes and sides, were only found regarding the glenoid height, which has no relevance to the purpose of the present study.

The anatomic relationship between the PCA and the glenoid fossa has clinical significance because the PCA is used as a landmark for the posterior arthroscopic portal of the shoulder. Accurate placement of the posterior portal at the desired position in relation to the glenohumeral joint is useful if not necessary. However, according to our findings, the position of the PCA in relation to the glenoid fossa and to the glenohumeral joint presents great variability. Specifically, the PCA can be found from 0.35 cm above the most superior point of the glenoid to 2.27 cm below that point; or in other words, the acromion can leave the glenoid height completely uncovered or covered up to 64% of the glenoid. For the perpendicular distance between the PCA and the most superior point of the glenoid, the histogram in Fig. 3 demonstrates that there were not few cases with extreme

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<thead>
<tr>
<th>Table I</th>
<th>Summarized results of the present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Specimens</td>
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<tr>
<td>Glenoid height, cm</td>
<td>140</td>
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<tr>
<td>Distance between PCA and most superior point of the glenoid, cm</td>
<td>140</td>
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<tr>
<td>Posterior coverage of the glenoid fossa by the acromion, %</td>
<td>140</td>
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CI, confidence interval; ICC, intraclass correlation; PCA, posterolateral corner of the acromion; SD, standard deviation; SEM, standard error of mean.

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<tr>
<th>Table II</th>
<th>Student t test for equality of means for sex differences</th>
</tr>
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<tbody>
<tr>
<td>Variable</td>
<td>Sex</td>
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<tr>
<td>Glenoid height, cm</td>
<td>Male</td>
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<td></td>
<td>Female</td>
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<tr>
<td>Distance between PCA and most superior point of the glenoid, cm</td>
<td>Male</td>
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<tr>
<td>Posterior coverage of the glenoid fossa by the acromion, %</td>
<td>Male</td>
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<td>Female</td>
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CI, confidence interval; PCA, posterolateral corner of the acromion; SED, standard error of difference.

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<th>Table III</th>
<th>Student paired t test for equality of means for side differences</th>
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<tr>
<td>Variable</td>
<td>Side</td>
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<tr>
<td>Glenoid height, cm</td>
<td>Right</td>
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<td>Left</td>
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<tr>
<td>Distance between PCA and most superior point of the glenoid, cm</td>
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CI, confidence interval; PCA, posterolateral corner of the acromion; SED, standard error of difference.
values. Actually, 19.29% of cases were between −0.35 and 0.09 cm, and 5.71% were between 1.83 and 2.27 cm. Such a great diversity of the PCA location among individuals confirms the hypothesis that the relationship between the PCA and the glenohumeral joint is not constant. Therefore, the use of a universal distance from the PCA will not lead to a consistent placement of the posterior arthroscopic portal of the shoulder in each patient and should be individualized according to the PCA position in relation to the glenoid.

According to Boyle et al., the portals should be placed with the subsequent procedure in mind to permit unhindered instrument access to relevant anatomic structures. Other authors suggest that the posterior arthroscopic portal should be positioned at a different distance from the PCA, depending on the expected underlying lesions.

Strobel locates the classic posterior portal 2 to 3 cm below and 1 to 2 cm medial to the PCA, but during arthroscopy of the subacromial space suggests that the posterior portal should be higher than the classic one, specifically 1 to 2 cm below the PCA.

Burkhart et al. consider the classic posterior portal to be too superior and too lateral because the scope enters the joint so close to the posterosuperior labrum that this structure can be difficult to evaluate. Finally, they suggest that the posterior portal should be made 4 to 5 cm below and 3 to 4 cm medial to the PCA.

Wherever (around the ideal entry point) the posterior portal is positioned, a surgeon could probably succeed to insert the arthroscope into the glenohumeral joint. Nevertheless, the surgeon’s purpose is not only to get into the joint but also to be precise regarding the position of the posterior portal in relation to the glenohumeral joint, as shown by the descriptions of Burkhart et al. and Strobel. However, according to our findings on the variability of the PCA position, being so precise when using the PCA as a landmark is not easy. Accurate placement of the posterior portal might be assisted by preoperative knowledge of the PCA position.

The present study found out that the universal use of a certain distance from the PCA might not lead to an accurate and safe placement of the shoulder posterior portal in every patient. Thus, the distance should be individualized according to the PCA position in relation to the glenoid, or the PCA should not be used as a landmark for the shoulder posterior portal. Experienced shoulder arthroscopists may likely find the desired entry point for the posterior portal by palpation, without preoperative knowledge of the PCA position in relation to the glenoid. Location of the “soft spot” by palpating the interval between infraspinatus and teres minor muscles may be very helpful. However, that interval, as well as other anatomic structures, may not be easily palpable in obese patients, and also, the proper use of a bony landmark as a guide is useful for any surgical procedure. As a result, we believe that the PCA should continue to be used as a landmark, but we have to develop techniques to preoperatively estimate the PCA position in relation to the glenoid.

We suggest the addition of the true lateral scapular radiograph (Y lateral view) in the routine preoperative evaluation, which some authors already perform. Simply by inspecting the radiograph preoperatively, the surgeon could estimate how low the PCA is positioned in relation to the glenohumeral joint. Following this, the ideal distance of the posterior portal from the PCA could be individualized, taking also into consideration the subsequent procedure or the personal preference about the relation between the portal and glenoid fossa. Further research is needed to identify if such a radiograph helps to individualize placement of the posterior portal and achieve the desired position of the portal in relation to the glenoid.

A limitation of the present study is that the measurements were performed on dried bones, whereas during positioning of the posterior arthroscopic portal of the shoulder, the measurements are carried out on the patient, where soft tissues interfere between the skin and the glenohumeral joint, and thus, other factors may also influence the position of the posterior portal. Nevertheless, the purpose of the study was not to indicate a mathematical model about how many centimeters below the PCA the posterior portal must be placed but to find out if a certain distance from that point should be used in all patients or if the distance should be individualized. Because all measuring points belonged to the same bone, results would not change. Furthermore, although the PCA is not the only factor affecting the placement of the posterior portal, it is a basic landmark that is palpated, drawn, and taken into consideration before every shoulder arthroscopy and almost every shoulder surgical approach. For this reason, we believe that knowledge of the great variability between this landmark and the glenohumeral joint, which was found in the present study, would be important for every shoulder surgeon.

Conclusions

The position of the PCA in relation to the glenohumeral joint is quite variable. Therefore, the use of a universal distance from the PCA will not always lead to a consistent placement of the posterior arthroscopic portal of the shoulder. A future radiologic or clinical study, or both, might further clarify the role and the proper use of the PCA in accurate and safe placement of the posterior arthroscopic portal of the shoulder.

References


