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Agreement between physiotherapists rating scapular posture in multiple planes in patients with neck pain

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Agreement between physiotherapists rating scapular posture in multiple planes in patients with neck pain

Abstract

**Objective** Evaluation of scapular posture is an integral component of the clinical assessment of painful neck disorders. The aim of this study was to evaluate agreement between therapist judgements of scapula posture in multiple biomechanical planes in individuals with neck pain.

**Design** Inter-therapist reliability study

**Setting** Research laboratory

**Participants** Fifteen participants with chronic neck pain.

**Main Outcome Measures** Four physiotherapists recorded ratings of scapular orientation (relative to the thorax) in five different scapula postural planes (plane of scapula, sagittal plane, transverse plane, horizontal plane, and vertical plane) under four test conditions (at rest, and during three isometric shoulder conditions) in all participants. Inter-therapist reliability was expressed using both generalized and paired kappa coefficient.

**Results** Following adjustment for expected agreement and the high prevalence of neutral ratings (81%), on average both the generalised kappa (0.37) as well as Cohen’s Kappa for the two therapist pairs (0.45 and 0.42) demonstrated only slight to moderate inter-therapist reliability.

**Conclusions** The findings suggest that ratings of scapular posture in individuals with neck pain by visual inspection has only slight to moderate reliability and should only
be used in conjunction with other clinical tests when judging scapula function in these patients.
Agreement between physiotherapists rating scapular posture in multiple planes in patients with neck pain

Introduction

Evaluation of scapular function is an integral component of the clinical examination of a patient with mechanical neck pain. It is considered an important assessment point as scapular dysfunction is thought to perpetuate mechanical strain to pain sensitive cervical spine structures due to shared muscle attachments between the scapula and cervical spine. In support of this there has been some initial evidence of altered scapular posture at rest and during elevation of the upper limb in some individuals with neck pain compared to healthy controls. There are also studies that show an association between axioscapular muscle impairment and neck pain. While there are many proposed methods to evaluate elements of scapular function in clinical practice usually the initial assessment point is to observe for aberrant scapular alignment commonly referred to as scapular dyskinesis. Visual ratings of scapular posture have the advantage of being time efficient and of no cost. Although they are dependent on the subjective ratings of clinicians and lack the quantitative accuracy of 3-dimensional tracking devices they do appear to be clinically informative. However many potential sources of error exist. Primarily there is a lack of consensus regarding what constitutes ‘normal’ scapular posture and as such disagreement is inevitable when judgements are made regarding abnormality. This uncertainty that is underpinned by unclear margins of
normal/abnormal scapula posture is probably reflected in the modest findings of inter-
therapist reliability studies utilising visual ratings of scapular posture, [13, 20-24]

We postulate that visual ratings of scapular posture may have better utility if ratings
are divided and judged in multiple planes of reference[25, 26] consistent with
contemporary biomechanical descriptions of scapular and clavicular kinematics.[15,
27] Potentially separate evaluation of scapular posture in specific planes of reference
may improve agreement between therapists regarding scapula posture in clinical
practice. Our earlier studies using this approach to evaluate scapular posture in
multiple planes of reference has not supported this postulation demonstrating on
average only fair to moderate intra-therapist[26] and inter-therapist[25] reliability in
healthy individuals. We haven’t as yet tested the reliability of this approach in a
clinical population. Therefore the purpose of this study was to evaluate the inter-
therapist reliability of physiotherapist’s judgements of scapular posture in multiple
planes of reference in individuals with chronic neck pain during upper limb tasks. It is
anticipated that the findings will further define the scope of this form of assessment in
the clinical management of patients with musculoskeletal conditions of the upper
quadrant such as neck pain.
Methods

Design

Inter-therapist reliability study of four physiotherapists independently rating scapular posture in individuals with mechanical neck pain. Physiotherapists performing the ratings were all undertaking a post-graduate master’s degree in musculoskeletal physiotherapy and had a mean 4.25 years (range 2.5 to 7 years) experience. Participants in the study were blinded to the intention of the study.

Participants and setting

Fifteen volunteers (5 males and 10 females) with chronic mechanical neck pain participated in the study and had a mean (± SD) age of 29.2 ± 11.8 years, body mass index of 23.2 ± 3.5 kg/m², and Neck Disability Index[28] score of 14.1 ± 6.6 out of a possible 50 points.

Participants were included if they were aged between 18-60 years, reported neck pain of greater duration than 3 months, scored greater than 7/50 on the Neck Disability Index and demonstrated positive findings on a physical manual examination of the cervical spine (altered joint motion and painful reactivity to palpation).[29] The study was undertaken in a clinical research laboratory setting.

Participants were excluded from the study if they demonstrated a painful disorder of the shoulder girdle such as subacromial impingement, prior surgery in neck or shoulder, symptoms suggestive of a radiculopathy or positive findings on a neurological examination, or marked deviations in thoracic posture such as a significant kyphotic or scoliotic posture. These criteria were to limit recruitment to those participants appropriate for a diagnostic label of mechanical neck pain of
idiopathic origin such that a specific lesion in cervical structures had not been identified or cervical radiculopathy was not present[30] or participants did not demonstrate concurrent conditions such as painful shoulder girdle disorders or significant postural abnormalities of the spine.

Participants were recruited within the university and general community through electronic and written advertisements. Ethical approval for the study was granted by the Institutional Human Research Ethics Committee and all procedures were conducted according to the Declaration of Helsinki. Participants provided informed consent.

Outcomes

Posture of the scapula was rated in five different postural planes (Table 1, Figure 1) in an identical method to that described in our previous studies.[25, 26] Judgements of scapula posture were made relative to the thorax consistent with contemporary descriptions of scapular kinematics[15, 31] Therapists nominated one out of a possible three (middle rating always neutral) ordinal ratings for each of the five postural planes (Table 1)[26] based on literature describing ‘normal’ resting scapular posture.[19, 32] Ratings either side of the ‘neutral’ representing deviation of the scapular towards opposite directions within the plane. All therapists were familiar with this assessment method prior to commencing the study and one practice session with the principal researcher was undertaken before the commencement of the data collection period to ensure all therapists were familiar with applying and recording the three level classification scale when rating scapula posture.
Ratings for each plane were made over four postural perturbating test conditions of the shoulder girdle in standing that included: rest (arm positioned at rest by the subjects’ side), isometric shoulder flexion, abduction, and external rotation. The isometric test conditions were performed against a load cell connected to a computer that provided visual feedback of effort intensity to the participant. This ensured that all isometric tests were performed at a consistent low intensity (20% of maximal voluntary contraction (MVC)) (Figure 2).[26] These four different test conditions permitted evaluation of scapula posture under rest and directionally loaded (isometric tasks) conditions as recommended clinically.[1]

**Procedure**

Participants were familiarised with the test procedure and reference MVC values for each of the three isometric shoulder conditions (shoulder; flexion, abduction, external rotation) were recorded in a preliminary session (performed at least 48 hours prior to the experimental session to negate any fatiguing effects). MVC recordings were performed in an identical test position to the isometric test conditions during the experimental session. Participants stood with the shoulder in a neutral internal/external rotation position, elbow flexed to 90°, and the forearm in neutral pronation / supination. The application pad of the load cell was positioned immediately superior to the anterior and lateral elbow crease for recordings of isometric shoulder flexion and abduction (Figure 2), respectively, and immediately proximal to the wrist joint on the lateral aspect of the forearm for external rotation recordings. For each test direction participants were instructed to perform each trial at
their maximal effort and standardised visual and verbal encouragement was provided to facilitate a maximal effort. The peak of three MVC trails (one minutes rest was permitted between each trial) in each direction (flexion, abduction, external rotation) was recorded so that the isometric conditions during the experimental session could be performed at a standardized intensity of effort (20% MVC) in each direction.

During the experimental session participants stood in a relaxed position and were instructed to focus their gaze at a point directly in front of them. Participants were blinded to the intent of the observations and ratings (scapula posture) until the session was completed. All therapists stood approximately two meters behind the participants and were not permitted to perform any other evaluation of scapular posture (such as palpation) besides observation. Markings were made on the participants’ thorax to assist therapists in judging scapular posture relative to the thorax. These markings consisted of a 3 cm horizontal line between the T3/4 and T8/9 interspinous spaces, and a vertical line between the T3-T8 spinous processes (Figure 2); consistent with prior research in this field. [25, 26]

All ratings followed a standardized order for each participant. Ratings in each postural plane were first made for the rest condition, followed by postural ratings for the flexion, abduction, and external rotation isometric conditions, respectively. A five second period was permitted for therapists to make their rating in each postural plane with short rest periods between each rating. A designated therapist signalled which postural plane was to be judged, as well as when to commence and terminate a specific rating. The side to be tested first (left or right scapula) was alternated between participants. In total each therapist made 20 ratings for each scapula (four conditions * five postural planes). These ratings were made independently by each rater onto a
paper based assessment form in a folder that obscured any recordings from the view of the other raters.

Analysis

In our previous study we demonstrated that a generalised kappa may provide a better estimation of the overall agreement of multiple raters than calculating kappa coefficients (Cohen’s kappa and PABAK) for therapist pairs.[25] However, we also demonstrated that a generalised kappa may mask more extreme cases of agreement/disagreement than paired comparisons.[25] Therefore in this study we have calculated both generalised and paired kappa data. The overarching findings of the study were consistent regardless of which individual rater pairings were presented for the analyses; therefore only two paired rater combinations are presented to demonstrate the nature of potential discrepancies between generalised kappa coefficients and weighted (Cohen’s) kappa coefficients.

Data from the left and right scapula were utilised for analyses for each of the planes and conditions. Table 2 displays the proportion of neutral ratings for each plane. Inter-therapist agreement between all four therapists (therapist 1 to 4) was evaluated with a generalized kappa. Inter-therapist agreement between therapist pairs (Therapist One versus Two, Therapist Three versus Four) was evaluated with a weighted Cohen’s kappa statistics (STATA IC)[33] using weightings for disagreements of one level (0.5) and two levels (0.0) on the three level scapula position rating.[33] Exact agreement and exact agreement expected by chance (based on frequency of responses in each scapula position rating category) were calculated for each of the two therapist pairs.[34-36] Indexes for prevalence and bias were also calculated and utilised in calculating the PABAK coefficients for the two pairs of therapists [34, 35]
Results

Ratings of scapula posture were performed on all participants bilaterally. Data for all therapists (percentage of neutral ratings and the generalised kappa) and therapist pairs (exact and expected exact agreement, Cohen’s kappa, prevalence and bias indexes, PABAK) for each test condition in each plane is provided in Table 2. The magnitude of difference between the PABAK and Cohen’s kappa coefficient values (within same pair of raters) for all planes and conditions was negligible (mean difference=0.02, maximal difference=0.11). On this basis only the Cohen’s kappa values will be reported herein to describe kappa levels of agreement for the therapist pairs.

Scapular Plane: The proportion of neutral ratings in the scapular plane varied substantially (42-86%) over tests conditions. Percentage of exact agreement varied slightly over conditions for both therapist pairs (77 - 93% \( pr_{1/2} \), 77-83% \( pr_{3/4} \)) with similar mean (range) Cohen’s kappa (0.53 (0.24 – 0.71) \( pr_{1/2} \), 0.49 (0.3 – 0.68) \( pr_{3/4} \)) and generalised kappa (0.45 (0.25 - 0.61)) values.

Sagittal Plane: The proportion of neutral ratings varied between 60 – 79% in the sagittal plane. There was some discrepancy in the percentage of exact agreement between therapist pairs over test conditions (80 - 90% \( pr_{1/2} \), 67 - 83% \( pr_{3/4} \)) but very similar Cohen’s kappa values (0.5 (0.27 – 0.71) \( pr_{1/2} \), 0.52 (0.4 – 0.68) \( pr_{3/4} \)) and a slightly lower generalised kappa value 0.37 (0.31 - 0.44).

Transverse Plane: The proportion of neutral ratings in the transverse plane varied across conditions but were generally high (74 – 98%) and the percentage of exact agreement was consistent between therapist pairs (83 - 100% \( pr_{1/2} \), 87 - 100% \( pr_{3/4} \)). Both therapist pairs demonstrated mean Cohen’s kappa values in the moderate
agreement range 0.58 (0 – 1)\textsuperscript{pr1/2}, 0.42 (0 – 0.64)\textsuperscript{pr3/4}) but with a lower generalised
kappa of 0.31 (-0.03 - 0.52).

*Horizontal Plane:* There was a very high (93-100%) proportion of neutral scapular
ratings in the horizontal plane and a high percentage of exact agreement for both
therapist pairs (82 - 100%\textsuperscript{pr1/2}, 93 - 100%\textsuperscript{pr3/4}). Cohen’s kappa (0.2 (-0.29 – 0.63)\textsuperscript{pr1/2}
-0.02 (-0.03 – 0)\textsuperscript{pr3/4}) and a generalised kappa (0.14 (-0.01 - 0.29)) values were low in
the horizontal plane.

*Vertical Plane:* Ratings of neutral scapula posture were high (86-91%) in the vertical
plane and percentage exact agreement similar for both therapist pairs (83 - 90%\textsuperscript{pr1/2},
87 - 93%\textsuperscript{pr3/4}). Cohen’s kappa (0.4 (0.29 – 0.55)\textsuperscript{pr1/2}, 0.48 (0.3 – 0.64)\textsuperscript{pr3/4}) and the
generalised kappa of 0.55 (0.43 - 0.64) values were also similar showing moderate
levels of agreement.

**Discussion**

In this study we evaluated the agreement between multiple therapists for visual ratings
of scapular posture in patients with neck pain in five biomechanical planes of
reference under four different test conditions. Exact agreement was generally high (67
- 100%) for most postural planes. However, the mean kappa values across all planes
and conditions (0.37 (generalised kappa), 0.45 and 0.42 (Cohen’s Kappa for therapist
pairs)) were not high.[37] These lower kappa values suggest that after adjusting for
expected agreement and the high prevalence of neutral ratings (81% of ratings were
neutral), that judgement of scapular posture in individuals with neck pain by visual
inspection only, has on average slight to moderate inter-therapist reliability. These
reliability coefficients are similar to that found in our previous studies evaluating the
intra-therapist[26] and inter-therapist[25] reliability of visual ratings of scapular posture in healthy individuals (using the identical method of evaluation), and are also consistent with those reported in other inter-therapist reliability studies utilising visual ratings of scapular posture.[13, 20-23] Therefore the findings of this study together with our previous studies [25, 26] do not support our hypothesis that dividing ratings of scapular posture into separate planes of reference improve the agreement of ratings between therapists.

The findings of this study of seemingly high levels of exact agreement between therapist pairs that coincides with paradoxical low or moderate kappa can make interpretation of the findings regarding actual reliability of these measurements difficult. This is a well acknowledged limitation of reliability studies using nominal clinical measures in the literature [38, 39]. The best example of this paradox in this study is in the horizontal plane where there is a very high exact agreement (93-100%) together with a very low generalised kappa (0.14) in the presence of a very high level of neutral ratings (97%). Due to the lack of kinematic scapular measurement in this study it can not be determined if the high level of neutral ratings in this plane (and other planes) are a true reflection of scapular posture in this particular patient group, or merely a reflection of uncertainty when rating posture in this particular plane of the scapula.

From a clinical perspective the findings of this and previous studies [13, 20-23] suggests that while visual assessment of scapular posture may still be useful in evaluating the presence, or not, of aberrant scapular posture, it should only be considered in association with findings from additional relevant tests (for example,
responses to scapular repositioning, or tests using quantitative measurement) [11, 19, 40]. A particular limitation of using visual inspection alone is the uncertainty regarding the criteria for ‘normal’ scapular posture [11, 19, 32]. Therefore it may be difficult for clinicians to nominate the status of the scapula as ‘normal’ or ‘abnormal’ in the absence of substantial deviations in scapular alignment. Unfortunately, the nature of this reliability study does not allow us to provide further informed comment on potential objective criteria for more readily defining ‘normal’ scapular posture during visual inspection, but this may be a useful topic for future research.

Another interesting finding in this study was that inter-therapist agreement of scapular posture was on average lower for ratings at rest (0.19 (generalised kappa), 0.21 and 0.25 (Cohen’s Kappa for therapist pairs)) compared to the ratings during the isometric loaded tasks (0.44 (generalised kappa), 0.55 and 0.48 (Cohen’s Kappa)). This is in contrast to that reported by Struyf et al. [23] who found loaded task to not improve reliability compared to unloaded or rest conditions. However it should be emphasised that while there are some observable differences between the reliability coefficients at rest and during the loaded tasks in this study utilising this specific methodology, the differences are small and in reality all the reliability coefficients are relatively modest. Therefore the authors do not consider the findings from the present study to be in conflict with those reported by Struyf et al. [23]

Strengths, limitations and future research

The issue concerning the paradoxical low to moderate kappa coefficients coinciding with high exact agreement has been discussed and previously highlighted as in issue in reliability studies [38, 39]. We attempted to correct for this by adjusting for bias and
prevalence however this did not substantially alter outcomes consistent with our
previous study in healthy individuals.[25] A limitation of our study may also have
been the experience level of the therapists performing the measurements (who had
similarly experienced with up to 7 years clinical practice experience). However these
were fully qualified physiotherapists undertaking specialised postgraduate training in
musculoskeletal physiotherapy and therefore were not novice. Future studies could
investigate if differences in experience level impacts agreement between therapists.
Other important limitations of this study was that the participant sample was small
and we did not undertake any kinematic evaluation of scapula alignment during
observational ratings and therefore we are unable to determine the validity of the
ratings even if in the presence of good agreement. Future studies undertaking
concurrent kinematic measurements and observational ratings will permit evaluation
of the validity of ratings and not simply the agreement between therapists.
Additionally, identical to our previous studies[25, 26] we marked visual cues on the
participants thorax to assist judgement of scapular posture. It is noteworthy that
reliability of scapular ratings without these marking may not necessarily be equivalent
to those with these markings present. However, these markings are easy to replicate in
clinical practice if they were perceived by the therapist to improve accuracy. Future
studies may need to determine if such skin markings affect measurement reliability.

Conclusion

This study has shown that ratings of scapular posture in individuals with neck pain by
visual inspection alone has only slight to moderate inter-therapist reliability when
performed by multiple therapists. This relatively modest level of agreement warrants caution when making clinical decisions regarding scapula function based on observation alone. While it is intuitive to observe scapular alignment during the examination of a patient with neck pain, findings should be considered in association with findings from other relevant clinical tests to best inform decision making.
References


[37] Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33:159-74.


Figures

Figure 1 – The four therapists rated scapular posture in five different planes including the scapular plane (A), sagittal plane (B), transverse plane (C) (rotational planes of the scapula), vertical plane (D) and horizontal plane (D) (rotational planes of the clavicle).

Figure 2 - The isometric test condition shown here is for isometric abduction. The participants force is exerted against the unyielding resistance of an application pad (positioned immediately superior to the lateral elbow crease) that is attached to a load cell and ridged frame. The load cell is connected to a computer that converts the changes in voltage transmitted from the load cell during the contraction to a calibrated measurement of force (Newtons). This force measurement is displayed on a visual display unit providing the participants with continuous visual force feedback of the required contraction intensity (20% MVC).
### Tables

*Table 1* – Criteria for rating of scapular posture in the five planes

<table>
<thead>
<tr>
<th>Rating</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scapula Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Upwardly Rotated</td>
<td>Scapula spine has a strong supero-lateral inclination, medial scapula border has a strong infero-lateral inclination.</td>
</tr>
<tr>
<td>Neutral</td>
<td>Scapula spine has a slight supero-lateral inclination, medial scapula border has a slight infero-lateral inclination.</td>
</tr>
<tr>
<td>Downwardly Rotated</td>
<td>Scapula spine has a horizontal or infero-lateral inclination, medial scapula border has an infero-medial inclination.</td>
</tr>
<tr>
<td><strong>Sagittal Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Anteriorly Tilted</td>
<td>Inferior scapular angle is prominent relative to the thorax and the superior angle.</td>
</tr>
<tr>
<td>Neutral</td>
<td>Scapula sits flush on the thorax with no prominence of the inferior scapular angle.</td>
</tr>
<tr>
<td>Posteriorly Tilted</td>
<td>Scapular has minimal or no forward inclination, superior angle is prominent relative to the thorax.</td>
</tr>
<tr>
<td><strong>Transverse Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Internally Rotated</td>
<td>Entire medial scapular border is prominent relative to the thorax.</td>
</tr>
<tr>
<td>Neutral</td>
<td>Scapula is rotated forward (in the vicinity of 30 degrees) with no prominence of the medial scapular border.</td>
</tr>
<tr>
<td>Externally Rotated</td>
<td>Scapula has minimal or no forward rotation in the transverse plane.</td>
</tr>
<tr>
<td><strong>Vertical Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Elevated</td>
<td>Medial scapular spine and inferior scapular angle superior to the T3-4 and T7-9 spinous processes, respectively.</td>
</tr>
<tr>
<td>Neutral</td>
<td>Medial scapular spine and inferior scapular angle level with the T3-4 and T7-9 spinous processes, respectively.</td>
</tr>
<tr>
<td>Depressed</td>
<td>Medial scapular spine and inferior scapular angle inferior to the T3-4 and T7-9 spinous processes, respectively.</td>
</tr>
<tr>
<td><strong>Horizontal Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Protracted</td>
<td>Medial scapular border rests further than approximately 2 inches from the midline.</td>
</tr>
<tr>
<td>Neutral</td>
<td>Medial scapular border rests approximately 2 inches from the midline.</td>
</tr>
<tr>
<td>Retracted</td>
<td>Medial scapular border rests closer than approximately 2 inches from the midline.</td>
</tr>
</tbody>
</table>
Table 2 – Inter-therapist agreement including calculations for ‘all raters’ and ‘paired raters’. Data is included for percentage of cases with neutral ratings from all raters (%neutral), general kappa values for all raters, as well as agreement and expected agreement values, Cohen’s kappa prevalence index (PI), bias index (BI), and prevalence adjusted bias adjusted kappa (PABAK), for the paired raters.
<table>
<thead>
<tr>
<th>Condition</th>
<th>All raters</th>
<th>General kappa</th>
<th>Raters one versus two</th>
<th>Cohen’s kappa</th>
<th>PI</th>
<th>BI</th>
<th>PABAK</th>
<th>Raters three versus four</th>
<th>Cohen’s kappa</th>
<th>PI</th>
<th>BI</th>
<th>PABAK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Neutral</td>
<td></td>
<td>Exact agree (%)</td>
<td>Expected exact agree (%)</td>
<td></td>
<td></td>
<td></td>
<td>Exact agree (%)</td>
<td>Expected exact agree (%)</td>
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<tr>
<td>Scapular</td>
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<tr>
<td>Rest</td>
<td>86</td>
<td>0.25</td>
<td>83%</td>
<td>78%</td>
<td>0.24</td>
<td>0.77</td>
<td>0.17</td>
<td>0.25</td>
<td>80%</td>
<td>71%</td>
<td>0.30</td>
<td>0.67</td>
</tr>
<tr>
<td>Flexion</td>
<td>84</td>
<td>0.44</td>
<td>93%</td>
<td>77%</td>
<td>0.71</td>
<td>0.73</td>
<td>0.07</td>
<td>0.81</td>
<td>83%</td>
<td>70%</td>
<td>0.44</td>
<td>0.63</td>
</tr>
<tr>
<td>Abduction</td>
<td>55</td>
<td>0.50</td>
<td>77%</td>
<td>52%</td>
<td>0.51</td>
<td>0.30</td>
<td>0.23</td>
<td>0.59</td>
<td>83%</td>
<td>48%</td>
<td>0.68</td>
<td>0.03</td>
</tr>
<tr>
<td>Ext. Rotn</td>
<td>42</td>
<td>0.61</td>
<td>83%</td>
<td>50%</td>
<td>0.66</td>
<td>0.10</td>
<td>0.17</td>
<td>0.63</td>
<td>77%</td>
<td>51%</td>
<td>0.52</td>
<td>0.23</td>
</tr>
<tr>
<td>Sagittal</td>
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Figure 1

A. Upward rotation
B. Anterior tilting
C. External rotation
D. Elevation

Downward rotation
Posterior tilting
Internal rotation
Retraction
Protraction
Depression
Figure 2