The Effect of Scapular Taping on Shoulder Joint Repositioning

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Context: There is a lack of research on the effects of scapular tape on shoulder joint repositioning.

Objective: To quantify the effects of scapular taping on shoulder joint repositioning during flexion and abduction.

Design: Repeated measures before and after trial.

Setting: Academic institution.

Participants: 36 subjects without shoulder pathology.

Intervention: Scapular taping with flexion and abduction.

Main Outcome Measures: Lateral scapular slide test, plumb-line assessment, and a depth measurement. Absolute error in joint repositioning in flexion and abduction at 3 angles with and without scapular taping was measured.

Results: No differences were found for tape vs no tape in flexion (P = .92) or abduction (P = .40) or between winging and nonwinging subjects in flexion (P = .62) or abduction (P = .91).

Conclusions: Scapular taping has no effect on joint repositioning during active shoulder flexion or abduction. Scapular winging does not affect active joint repositioning after scapular taping.

Key Words: physical therapy, proprioception, kinesthesia


Normal movement at the shoulder requires finely tuned and highly coordinated actions of four joints (sternoclavicular, acromioclavicular, glenohumeral, and scapulothoracic) and several uniarticular and biarticular muscles. The culminating effects of these actions is commonly referred to as glenohumeral rhythm. An essential component of glenohumeral rhythm is proper scapular positioning. The relatively small glenoid fossa of the scapula serves as a base for the much larger humeral head. This incongruent arrangement is augmented by the strength of a multitude of muscles that attach from the scapula to the spine, ribcage, and humerus. These

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structures ultimately affect the capsular stability at the glenohumeral joint. A strength imbalance of muscles controlling the position of the scapula can lead to changes in posture and shoulder function. For example, tightness of the anterior shoulder musculature contributes to the commonly seen "forward shoulder" posture. Anterior tightness or weakness of the posterior cuff muscles and scapular stabilizing muscles can lead to tilting, winging, or abduction of the scapula. These alterations in the orientation of the humeral head in relation to the glenoid fossa have been shown to cause changes in shoulder kinematics that can lead to shoulder dysfunction or injury.

Joint repositioning also plays a role in shoulder function. It enables us to detect the spatial orientation of our limbs without visual input. Joint repositioning can be defined as a specialized sensory modality of touch that detects joint movement (kinesthesia) and joint position (joint-position sense). Biological inputs that contribute to joint repositioning include neuromuscular, ligamentous, afferent, and capsular structures. Consequently, any alterations in the capsular tension, surrounding musculature, or joint position most likely will affect joint repositioning and influence limb movement. Most of the previous research investigating joint repositioning has focused on the lower-extremity structures of the ankle and knee. Only recently has emphasis been placed on the shoulder. Forwell and Carnahan, Lephart et al, and others describe shoulder joint repositioning as essential for hand placement, fine motor control, and dynamic shoulder stability. Previous studies by Carpenter et al, Voight et al, and Sterner et al have demonstrated that kinesthesia is negatively affected by fatigue. Kinesthesia has also been shown to be negatively affected by the occurrence of anterior shoulder dislocation. Research on shoulder joint repositioning has shown that joint repositioning is negatively affected by glenohumeral joint laxity, subluxation, and scapular malalignment. Forwell and Carnahan also identified losses in kinesthetic sense for active shoulder repositioning in subjects who have been diagnosed with anterior shoulder instability.

Very little research has been performed regarding the effects of various treatment interventions on joint repositioning of the shoulder. Scapular taping is often used in the clinic to reposition a poorly aligned scapula, so as to decrease shoulder pain and to assist in normal motion of the shoulder until proper muscle strength and balance have been restored. Despite the popularity and empirical success of this practice, little research has appeared in the literature to determine its effects. In a review of the literature, the only peer-reviewed articles investigating the effects of scapular taping were performed by Host and Schmitt and Snyder-Mackler, who investigated scapular impingement. Both used a single-case design approach that might serve to limit the generalizability of the findings from the studies. Although studies have shown that bandages or compressive sleeves around the knee increase joint repositioning, there is a lack of
research on the effects of scapular tape or compressive garments on joint repositioning at the shoulder.79,19

The purposes of this study were to (1) quantify the effects of scapular taping on shoulder joint repositioning, (2) determine changes in joint repositioning with changes in joint angle position and plane of motion, and (3) determine any differences scapular taping might have on shoulder joint repositioning for individuals who present with and without scapular winging.

**Methods**

A group of 24 women and 12 men (age 25.4 ± 3.4 years, ht 169.2 ± 8.4 cm, mass 67.1 ± 11.0 kg) without shoulder pathology participated in the study. Inclusion criteria for participation included the absence of left-shoulder subluxation, dislocation, or physical therapy for the left upper extremity within the preceding 6 months and no previous surgery on the left upper extremity within the preceding 5 years. All of the subjects meeting the criteria signed a consent form approved by the Institutional Review Board for the Protection of Human Subjects at Slippery Rock University.

Three methods were used to assess scapular position. These measures included the lateral slide test (LST),20 a depth measure of the medial border of the scapula, and plumb-line assessment of the shoulder. The LST was performed with each subject in 3 different shoulder positions. These included 0° of abduction, 45° of abduction with hands on the hip with digits 2 and 3 on the ASIS and the thumb on the iliac crest, and 90° of shoulder flexion and internal rotation. To standardize width of scapular protraction, marks were made on the skin using a felt pen, and tape measurements were referenced as the distance from the inferomedial angle of the scapula to the spinous process of T7. The inferior angle is coincident with T7 and is commonly referenced clinically to determine scapular winging.

A depth measurement was recorded using a 6-in metal combination square (Johnson Level and Tool Manufacturing Co, Inc, Mequon, Wisc) placed along the vertebral column to the inferior angle to quantify the posterior displacement of the inferior angle from the spinous process of the thoracic vertebrae at the level of T7. To standardize this measure, each subject’s arm was placed in extension and internal rotation with the dorsum of the hand at the lumbosacral junction (Figure 1).

Forward shoulder posture was assessed in reference to vertical plumb line using the method outlined by Kendall et al.21 To account for skeletal size across subjects, anthropometric calipers (Lafayette Instrument Corp) were used to measure the horizontal distance between the acromion processes. This measure was defined as the biacromial distance.

Proprioceptive testing was measured using angle reproduction while each subject was seated on a Biodex isokinetic dynamometer (Biodex, Inc, Shirley, NY). All subjects were randomly assigned to perform either tape
or no-tape trials for the their first experimental condition. The order of testing was also randomized with regard to the plane and angles of motion. Data were collected at shoulder positions of 60°, 90°, and 120° of flexion and abduction.

Subjects were seated adjacent to the Biodex with the long lever arm (D2) attachment secured to the machine. Once seated, all subjects were blindfolded to reduce the effects of visual input. Subjects were required to actively maintain complete elbow extension at all shoulder angles during testing. Each subject was then asked to actively hold the shoulder-angle test position (60°, 90°, and 120°) for 5 seconds. The arm was then passively returned to the starting position, and the subject was allowed to rest for 10 seconds. The subject was then instructed to actively raise the arm until perceiving that he or she had achieved the previous shoulder position. At this point the subject stopped the lever from moving by pressing the “kill switch” on the device using the contralateral upper extremity. This process was repeated twice for each of the 3 angles in flexion and abduction. The absolute difference between the desired angle and the actual angle achieved was recorded as the subject’s error score. The described procedure was continued for all test conditions for a total of 12 trials per subject (6 trials with tape and 6 trials with no tape). One author performed the joint-positioning tests on the Biodex for all subjects, and another was solely responsible for the data collection on the other measures.
The McConnell method\textsuperscript{22} was used as the preferred method for the taping trials because of its clinical popularity and standardization of application (Figure 2). Hypafix\textsuperscript{®} prewrap (Smith and Nephew) was used as the underlayer before applying the Leukotape\textsuperscript{®} (Smith and Nephew) to position the shoulder.

All data were analyzed using the SPSS software package (version 8.0). Intraclass correlations were calculated to determine the intrarater reliability between the 2 trials for each of the 3 joint angles (60°, 90°, and 120°). The significance level for each analysis of variance ANOVA) was set a priori at $\alpha = .05$. Data from all subjects (N = 36) were used in a 2 x 3 repeated-measures ANOVA to assess the effect of tape and joint angle position on shoulder joint repositioning for flexion. A separate 2 x 3 ANOVA was calculated for the abduction condition. For these 2 analyses the subjects were not separated according to the classification winged vs nonwinged.

Because the literature does not provide guidelines for quantifying and classifying winging, the researchers used the depth of the inferior angle from the thoracic wall to partition subjects into either a winging or a nonwinging subgroup. The range of values on this measure was calculated and then divided into thirds. The cut-off values were then used to partition the top and bottom third of the subjects into either a winging or a nonwinging subgroup. The middle-third scores were excluded for this portion of the analysis to increase the discrimination in measurement between the 2 groups. This resulted in a total of 20 subjects for analysis. Of these 20, 11 were in the nonwinging group and 9 were in the winging group. A 2 x 2 x 3 (Tape x Winging x Angle) mixed ANOVA was performed for flexion to determine the effect of scapular taping on shoulder joint reposi-
tioning in individuals with and without winging. The same ANOVA was run on the abduction data.

Pearson correlation coefficients were calculated for all subjects, the winging subgroup only, and the nonwinging subgroup to determine the strength of association between the depth measurement and the plumb line and LST values at 0°, 45°, or 90°.

Results

The intraclass correlation test–retest values for the 2 trials for each of the 3 joint angles ranged from .96 to .99, with standard errors of the means ranging from .23 to .80. These values indicated excellent test–retest reliability across the 3 angles. Because reliability was considered excellent, only the data from trial 1 were used for analysis. Figures 3 and 4 show means and standard errors for the tape vs no-tape condition for the entire subject pool for flexion and abduction, respectively. For these 2 analyses the subjects were not separated according to the classification winged vs nonwinged. Figures 5 and 6 show results comparing the winging and nonwinging subgroups for flexion and abduction, respectively.

The LST scores and depth measurements were normalized for each skeletal size by dividing each subject's biacromial distance by the original LST measurements or the depth measurements. Subjects in the winging group had an average scapular-depth measurement of 0.83 mm, vs 0.24 for the nonwinging group. Plumb-line measures for forward shoulder posture were 30.2 mm and 31.0 mm for the winging and nonwinging groups, respectively. Scores for the LST ranged from a minimum of 0.21 cm at 0° to a maximum of 0.27 cm at 90°.

The results of the 2 × 3 repeated-measures ANOVA showed no differences in joint repositioning for the tape versus no-tape conditions in flexion.
Figure 4  Absolute error scores for abduction trials for all subjects comparing tape and no-tape treatments.

(F = 0.01, P = .92, df 1,35) or abduction (F = 0.74, P = .39, df 1,35). The power calculations for the 2 × 3 repeated-measures ANOVA yielded a power of .05 for flexion and .13 for abduction.

Data for the depth measurements were divided into 2 subgroups (winging and nonwinging). The depth measurements of the inferior angle of the scapula ranged from 4 to 38 mm. Subjects in the low third (4–15.3 mm) were placed in the nonwinging subgroup and those in the high third (26–38 mm) were placed in the winging subgroup.

The results of the values for the 2 × 2 × 3 mixed ANOVA for flexion (F = 1.26, P = .28, df 1,18) and abduction (F = 1.65, P = .22, df 1,18) indicated no differences for the winging subjects regarding joint repositioning for the

Figure 5  Absolute error scores for flexion trials for winging and nonwinging subjects.
tape and no-tape conditions in flexion ($P = .28$) or abduction ($P = .22$). For the $2 \times 2 \times 3$ mixed ANOVA, power was equal to .23 for flexion and .19 for abduction.

There were significant correlations ($P = .01$) between LST at $0^\circ$ and $45^\circ$ for the entire group and also for subjects classified in the nonwinging group. The LST measurements at $90^\circ$ showed significant correlations ($P = .01$) for the $0^\circ$ and $45^\circ$ measurements. There was no significant correlation noted for the winging subgroup. The plumb-line and depth measurements were not significantly correlated.

### Comments

Our initial purpose in conducting the study was to determine whether scapular taping affects neuromuscular feedback or joint repositioning. The results of this study indicate that scapular taping does not significantly affect joint repositioning at the shoulder. The pattern of data showed smaller absolute error for the tape condition in both flexion and abduction, and the standard errors were relatively large. Data analyses also showed large variability in the difference scores. Low power values for all of the ANOVAs were predominately the result of a relatively small sample size. These factors might have contributed to the lack of statistical significance. These results led us to partition subject grouping based on the presence of winging among subjects to determine whether there was a bias in the analysis by not separating subjects based on scapular orientation before taping.

The Pearson correlation coefficient revealed that the LST measurements at $0^\circ$, $45^\circ$, and $90^\circ$ were correlated significantly for the intermediate and nonwinging subgroups, but only the LST measurements for $0^\circ$ and $90^\circ$ were significantly correlated for the winging subgroup. Because these subgroups were divided based on depth measurements, this might suggest that depth
is a useful criterion to show that original scapular position is a good indicator of scapular position throughout the range.

Errors in palpation of the bony landmarks of the scapula and differences in body types and posture of the subjects, such as thoracic kyphosis, might have affected the accuracy of the measurements. With the dorsum of the hand positioned at the lumbosacral junction, the degree of tightness in the posterior capsule could have influenced the position of the head of the humerus and scapula, resulting in increased winging or tilting. This suggests that a single planar measure of depth might not be the most comprehensive indicator of scapular winging and scapular position. Because there is no valid operational definition of optimal scapular position, we chose to use the depth measurement from the inferior angle from the thoracic wall to best indicate the presence of scapular winging. This method of defining winging can be considered a limitation of the study because of its 2-dimensional method of analysis. Nonetheless, we attempted to provide a measure that would be easy to administer clinically.

Subjects' scapular position was not reassessed after taping because of potential errors in palpation through multiple layers of tape. It is therefore unknown to what degree the shoulder position was actually realigned before joint-repositioning measurements were taken. The force used to reposition the humeral head could not be directly measured and might not have been consistently measured, although in our study we attempted to reduce this bias by having the same investigator apply the tape to each subject.

Joint repositioning was measured indirectly through angle reproduction using the Biodex. Because motion was not isolated solely to the shoulder complex, subjects might have received proprioceptive input from the adjacent structures of the elbow and the wrist. In addition, joint repositioning is only 1 component that influences proprioception. Input from vestibular, visual, and auditory systems all can play a role in the final outcome of joint-position orientation. We attempted to control for the visual influence by blindfolding all subjects during testing, but no experimental controls were instituted to measure additional effects. The application of the tape might have also given cutaneous sensation that contributed proprioceptive information.

A major limitation of our study concerns the resolution of the Biodex in measuring joint repositioning. The machine only outputs values to the nearest degree, which does not allow smaller errors in position to be detected. An apparatus allowing for greater resolution might have shown smaller but significant differences in joint repositioning in the tape vs no-tape conditions.

Two planes of motion, flexion and abduction, were tested to investigate the difference in joint repositioning when the capsule tightens at the varied ranges of motion and when different muscles are used. The taping method neither increased nor decreased the subjects' ability to differentiate joint position for flexion or abduction movements. Although there were no
positive influences on joint repositioning, neither were there any associated negative effects. Therefore, tape does not appear to affect joint repositioning as measured by reproduction of limb position. This information could be useful for the clinician who is concerned that scapular taping might interfere with joint repositioning during shoulder rehabilitation.

Understanding the effect of joint repositioning in injury, treatment, and rehabilitation is essential for comprehensive rehabilitation of shoulder pathology. In this study, scapular taping did not affect joint repositioning in the planes of shoulder flexion and abduction. Furthermore, initial scapular position (ie, winging or nonwinging) did not significantly influence the taping’s effectiveness. Further research is needed to determine the effects of joint repositioning at the shoulder complex. The efficacy of scapular taping on related areas such as strength and endurance training also needs to be further investigated.

References


