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Clinical Study

Effect of Box Taping as an Adjunct to Stretching-Strengthening Exercise Program in Correction of Scapular Alignment in People with Forward Shoulder Posture: A Randomised Trial

Neha Dewan,[1] Kavitha Raja,[2] Ganesh Balthillaya Miyaru,[3] and Joy C. MacDermid[1,4]

[1] *School of Rehabilitation Sciences, McMaster University 1400, Main Street West, Hamilton, ON, Canada L8S 1C7*
[2] *JSS College of Physiotherapy, JSS Hospital Campus, Mysore, Karnataka 570004, India*
[3] *Department of Physiotherapy, Manipal College of Allied Health Sciences, Manipal University, Manipal, Karnataka 576104, India*
[4] *Hand and Upper Limb Centre, St. Joseph's Health Centre, London, ON, Canada N6A 4L6*

Correspondence should be addressed to Neha Dewan; dewann@mcmaster.ca

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Objective. The objective of this study was to provide preliminary estimates of effects of box taping as an adjunct to stretching-strengthening exercise program on scapular alignment in healthy subjects with forward shoulder posture (FSP). *Methods*. Sixty subjects were screened and 38 asymptomatic subjects with FSP were allocated into box taping and standard treatment group using block randomization. Both groups received a supervised stretching-strengthening exercise program and postural advice for 15 sessions over 3 weeks. In addition, box taping was applied to the intervention group. Static and dynamic scapular alignment was recorded at baseline, 7th and 15th sessions. Differences over time and between the treatment groups were determined using repeated measures of analysis of variance (ANOVA). *Results*. Twenty subjects completed the study. Both interventions were well tolerated and resulted in improvements in static and dynamic postural indicators over time in both groups ($P < 0.05$) except for dynamic scapular alignment by the 15th session. We were under powered to detect differences between the groups ($P < 0.05$). *Conclusions*. This study suggests postural exercises improve scapular alignment; but a large RCT is required to determine whether the addition of box taping is indicated, and whether this preventative approach reduces the incidence of upper quarter musculoskeletal disorders. This trial is registered with CTRI/2013/10/004095.

1. Introduction

Patients referred to physical therapy with impaired upper extremity function, often exhibit postural alterations [1]. Forward shoulders is a common maladaptive posture which occurs in up to 73% of the group of healthy subjects between the ages of 20 and 50 years [2, 3]. Kendall et al. described forward shoulders as abduction and elevation of the scapula and a forward position of the shoulders, giving an appearance of a hollow chest [4, 5]. Forward Shoulder Posture (FSP) is characterized by a protracted, downwardly rotated, and anteriorly tipped scapula position with increased cervical lordosis and upper thoracic kyphosis [6]. This pattern may be associated with tightness of serratus anterior, pectoralis minor, pectoralis major and upper trapezius muscle, and weakness of middle and lower trapezius [3]. The imbalance in muscle function is believed to result in reduction of amplitude in posterior tilting and lateral rotation of the scapula during arm elevation [7–9]. The literature has shown that altered scapular kinematics and associated muscle imbalance in FSP places the anterior acromion in close proximity to rotator cuff tendon and increase the potential for subacromial impingement [3, 8, 10–12].

FSP and associated muscle imbalance is one of the factors contributing to episodes of head, neck, and shoulder pain [3, 13, 14] and multiple upper quarter dysfunctions such as bicipital tendinitis [15], thoracic outlet syndrome [16], painful trigger areas [17], and neuropathies [18]. Since few prospective studies have included patients prior to development of these disorders, cause-and-effect has not been clearly established [3]. However, there is an assumption that this association does indicate that FSP is a maladaptive posture that warrants correction.

Many shoulder rehabilitation programs emphasize scapular muscle control [19–21] which indicates that despite limitations in evidence on causal relationship, there is clinical application of the association between scapular malalignment and shoulder pathology [19–25]. Additionally, there are few studies supporting the evidence that changing posture influences impairment [26–28]. Previous researchers have described exercise programs focused on stretching and strengthening exercises to correct the altered posture [13, 29–35]. Few of these studies specifically deal with subjects having shoulder pathology [27] or swimmers [13, 34]. There is a dearth of the literature concerning correction of FSP as a preventive measure against upper quarter dysfunction. Preliminary studies demonstrated that strengthening of the posterior scapular stabilizers combined with stretching of the pectoral muscles given over a period of six weeks can result in improved muscle strength, produce a more erect upper trunk posture, increase scapular stability, and alter scapulohumeral rhythm in healthy subjects [32, 33]. These studies indicated that there was significant change in dynamic position of scapula, but no change in resting position of scapula. A recent scoping review has well recognized the effectiveness of stretching and strengthening of scapular abductors and adductors, respectively, or a combination of both on the resting position of scapula in people with forward shoulder posture [30]. The authors make definite conclusions about relationship between scapular muscle strength and resting position of scapula due to weaknesses in study design. In particular, the review noted that the techniques used to determine the resting position of scapula had questionable validity.

Taping is believed to affect the resting position of the scapula and assist in maintaining the proximal shoulder-girdle stability necessary to perform elevation of the arm [35]. With the tape holding the scapula in a more proper alignment, the patient can then use the shoulder without further reduction of the space between the acromion and humeral head [36]. Additionally, the tape provides a feedback mechanism allowing the patient to feel normal alignment and positioning of the shoulder complex. The two most frequently proposed mechanisms of taping are proprioceptive and mechanical [37]. The benefits of taping are still under contention. However, it is still widely accepted in clinical practice that taping is a useful treatment modality [38–40]. The clinical application of scapular taping has been supported in one case reports [36], one cross over study [41] done with a wash-out period of one hour, one double blinded randomised controlled trial [42], and a recent pilot randomised control trial [39] in which taping was one component of treatment provided to patients with shoulder pain. Over the past decade, taping has been proven to be an effective adjunct in reducing pain, improving proprioception and muscle recruitment pattern, and assists in motor control and function in special populations such as swimmers and violinists with FSP [43, 44]. Although taping is used for the correction of postural abnormalities and many studies are available regarding beneficial effects of taping in symptomatic and specific group of population, nevertheless, there is lack of evidence for its use in clinical practice for upper quarter postural correction in healthy subjects who are at risk of musculoskeletal disorders due to altered posture.

Box Taping is one of the scapular taping techniques explained to correct the scapular position [45]. To our knowledge, this is the first study done to determine additive effects of scapular taping in correction of both static and dynamic scapular alignment over a period of 3 weeks. The objective of this study is to provide preliminary estimates of effects of box taping as an adjunct to stretching-strengthening exercise program on scapular alignment in healthy subjects with forward shoulder posture.

2. Material and Methods

2.1. Prestudy to Establish Cut Offs for Normalized Scapular Abduction Ratio. Normalised scapular abduction ratio (NSA ratio) is considered as one of the reliable measures for scapular position [46] and can be used to discriminate between normal and abnormal scapular mechanics. However, there is no existing data for NSA ratio in Indian population who were the target audience for this study. Data for NSA ratio were collected from participants who had bilateral FSP on visual estimation ($n = 10$). This was to determine an objective cut off point for NSA ratio to include participants in our study.

FSP on visual estimation is decided if any one of the following findings were present [4, 5]:

(i) medial borders of scapula were not parallel to each other;

(ii) anterior shoulder point was anterior to sternal notch/hollowing of the chest present.

The mean NSA ratio in this group was 1.60 which was in close approximation with the mean NSA ratio seen in population from the United States [47, 48]. The group inclusion cut point values for our study were then set at ≥ mean NSA ratio of pilot sample.

2.2. Study Design and Participants. A randomised control trial (RCT) design was used in this study. A NSA ratio on measurement set at ≥1.60 was used as a criterion to define FSP. A convenient sample of 60 healthy participants was screened for FSP among graduate and postgraduate students from various departments of Manipal University. Thirty-eight healthy volunteers with FSP, aged between 18–35 years were included. Participants were excluded if they were symptomatic, had any neurological deficit in upper extremity, or any surgical intervention affecting the thorax and scapula.

All participants who fulfilled screening and eligibility criteria were informed about the study and written informed consent was taken before starting the procedure. The study was approved by institutional research committee of Manipal college of Allied Health Sciences.

2.3. Outcome Measures. Recording of static and dynamic scapular alignment measures was performed bilaterally by

Figure 1: Acromial distance: distance between the posterior border of acromion and table surface.

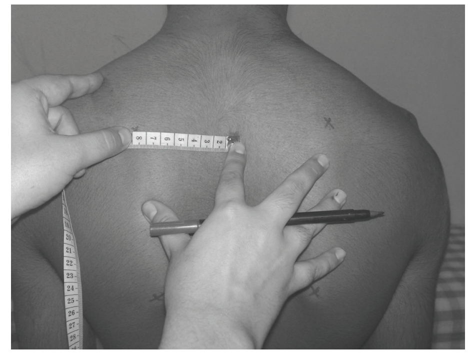

Figure 2: T 3 distance: horizontal distance from the third thoracic spinous process to the corresponding point on medial border of the scapula.

the primary investigator. All measurements were taken with measuring tape in centimetres.

For static scapular alignment, three tests were used [49] as follows.

(1) Acromial distance [49–53]: with the participants in supine lying, the distance between the posterior border of acromion and table was measured (Figure 1).

(2) T 3 distance [3, 49, 54]: this test was performed in standing position with the participant instructed to stay relaxed. The measurement of horizontal distance from the third thoracic spinous process to the corresponding point on medial border of the scapula was measured (Figure 2).

(3) Normalised scapular abduction ratio (NSA ratio) [46, 47]: NSA ratio was calculated by dividing the total scapular distance by length of scapula. Total scapular distance is the linear distance from the third thoracic vertebra to inferior angle of acromion. Length of scapula is distance from inferior angle of acromion to root of spine of scapula. The participants stood in relaxed position. Both total scapular distance and length of scapula was measured and NSA ratio was calculated (Figure 3).

For Dynamic scapular alignment: lateral scapular slide test (LSST) was done [46, 51, 53]. The participant stood in relaxed position and measurements were taken from inferior angle of scapula to 7th thoracic spinous process with the participant's arm in 3 different positions at 0 degree (arms relaxed on the sides), 45 degree (hands supported on hip and web space on iliac crest), and 90 degrees (with glenohumeral internal rotation) of abduction (Figure 4).

2.4. Randomisation and Group Allocation. The potential participants were contacted telephonically and were offered an appointment for a baseline assessment. After baseline measurements, participants were randomly assigned by the primary investigator to either of the box taping ($n = 20$) or standard treatment group ($n = 18$) using block allocation of 1 : 1. Each block consisted of 4 participants. The primary investigator, a trained physiotherapist who is the primary

(a)

(b)

Figure 3: NSA ratio: distance from posterolateral angle of acromion to thoracic spine process, (T 3): distance from posterolateral angle of acromion to root of spine of scapula.

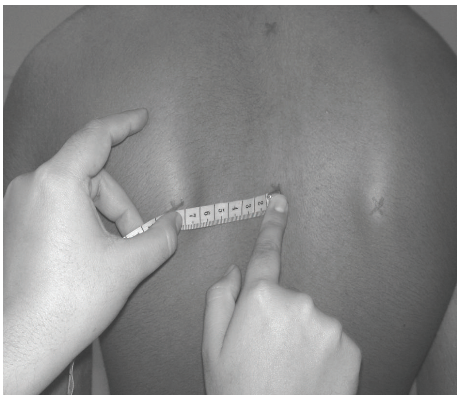

Figure 4: Lateral scapular slide test (LSST): distance from inferior angle of scapula to 7th thoracic spinous process.

Figure 5: Box taping technique.

author of this paper provided all treatment to both the groups and was not blinded to group allocation.

2.5. Intervention. The standard treatment program consisted of stretching-strengthening exercises and mobilization to counteract the muscle imbalances and joint restrictions that may be associated with FSP. The supervised stretching-strengthening exercise program (Box 1) consisted of passive stretching of tight anterior shoulder girdle muscles (pectoralis minor, pectoralis major, and upper trapezius), strengthening exercises using theraband for posterior scapular muscles (rhomboids, middle, and lower trapezius), and glenohumeral external rotators (infraspinatus and teres minor), thoracic spine mobilization exercise, and strengthening of upper back musculature to maintain proper head position and erect spinal curvature (as forward shoulder posture is found to be associated with forward head posture and thoracic kyphosis [6]). The exercise treatment of approximately 20 minute duration and postural advice to maintain correct shoulder posture were given to both groups. One of the two treatment groups received box taping as an additional intervention to maintain normal scapular alignment. Taping was applied as per guidelines given by Morrissey [55]. Both groups received treatment for 15 sessions over a period of 3 weeks. Subjects were instructed to maintain the tape for about 4 hours/session. Outcome measures for scapular alignment were taken pretreatment and repeated after the 7th and 15th treatment sessions.

At the first session of the exercise program, the participants were introduced to the different levels of theraband (Hygenic Corp). The participants began exercises using the yellow nonlatex band at mild tension. The subjects were progressed to the next colour resistive band when they were able to perform required repetitions (Box 1), each with 10 seconds of hold without significant fatigue in the sequence: yellow, red, green, blue, and black. These exercises were individually adjusted and were progressed with higher level theraband and repetitions at the physiotherapist visits during the whole rehabilitation period.

Taping technique used was box taping [45]. Taping material used was non elastic leukotape. Participants were instructed to fully retract and depress their scapula. Two horizontal strips of tape were used to draw the medial border of scapulae together and two vertical strips were used to facilitate thoracic extension. One horizontal strip extended from superior angles of one scapula to superior angle of other scapula and other horizontal strip extended from inferior angle of one scapula to inferior angle of other scapula. The vertical strips overlapped the horizontal strips (Figure 5).

2.6. Statistical Analysis. Descriptive statistics (mean, SD) were computed for each study variable. Data was tested for normality and parametric tests were used for statistical analysis using SPSS version 18.0. The statistical significance was set at alpha < 0.05 at 95% confidence interval. Our study has investigated the effect of intervention on each variable on both sides at 3 different sessions. Each of these variables were analyzed using repeated measures of analysis of variance (ANOVA) with time as within-participant factor at 3 levels (baseline, 7th and 15th session) and group as between participant factor. Mauchly's test of sphericity was used to test homogeneity of variance. In case of significant Mauchly test results for sphericity, Greenhouse-Geisser correction was applied to adjust the tests, as recommended by Portney and Watkins [56]. Where indicated, post hoc multiple pairwise comparisons with Bonferroni correction were used.

3. Results

Nine participants dropped out from both the box taping and standard treatment group, leaving 20 patients for analysis. The groups were comparable before treatment (Table 1). The groups were also similar with respect to scapular alignment at the baseline (Table 2). The CONSORT diagram describing participant recruitment and retention is shown in Figure 6.

At 5% level of significance, ANOVA results revealed that there was a statistically significant improvement for two

Comprehensive exercise treatment program

(i) Stretching of tight anterior shoulder muscles (passive stretching)

Pectoralis minor/major, upper trapezius

1st 5 sessions—5 stretches, each with 30 seconds of hold

Next 10 sessions—10 stretches, each with 30 seconds of hold

(ii) Strengthening exercises for posterior scapular muscles and glenohumeral external rotators with therabands

Posterior scapular muscles—rhomboids, middle and lower trapezius

Glenohumeral external rotators—infraspinatus and teres minor

1st 5 sessions—5 repetition, each with 10 seconds of hold

Next 5 sessions—10 repetition, each with 10 seconds of hold

Last 5 sessions—15 repetition, each with 10 seconds of hold

(iii) Thoracic spine mobilization exercises

Subject was made to lie down supine on a wedge placed at the level of maximum thoracic kyphosis for 5 minutes

(iv) Strengthening of upper back musculature

Subject was made to lie down on a pillow under the chest in prone lying and was instructed to straighten the upper back

1st 5 sessions—5 repetition, each with a hold 10 seconds

Next 10 sessions—10 repetition, each with a hold of 10 seconds

Box 1

Table 1: Characteristics of participants ($N = 20$).

Characteristic	Experiment group ($n = 11$) Mean ± SD	Control group ($n = 9$) Mean ± SD	P value
Age (years)	21.64 ± 1.85	20.44 ± .52	0.06
Weight (kg)	61.63 ± 9.9	61.77 ± 10.8	0.97
Height (cms)	162 ± 6.4	159 ± 5.11	0.30
Male (n)	5	3	
Females (n)	6	6	

of the variables of static scapular alignment that is, NSA ratio (right side) and acromial distance (both sides), but no significant improvement in variables of dynamic scapular alignment in participants of box-taping group (Table 3). Contrarily, in the standard treatment group, statistically significant improvement ($P < 0.05$) was seen only in the NSA ratio bilaterally (Table 4). Over a period of 3 weeks, there was no statistically significant difference between the two groups for any of the static or dynamic scapular alignment variable as the observed P value was more than 0.05. Although, difference between two groups was not statistically significant, the following trend has been seen in measurements for static and dynamic scapular alignment.

3.1. Static Scapular Alignment. Following commencement of treatment, both groups showed improvement (decrease) in NSA ratio, acromial distance, and T 3 distance bilaterally (Tables 3 and 4). However, acromial distance on both sides improved more in taped group than in standard treatment group (Figure 7). Similarly, in post hoc analysis, pair wise comparison indicated that NSA ratio (right side) and acromial distance (both sides) have shown statistically significant

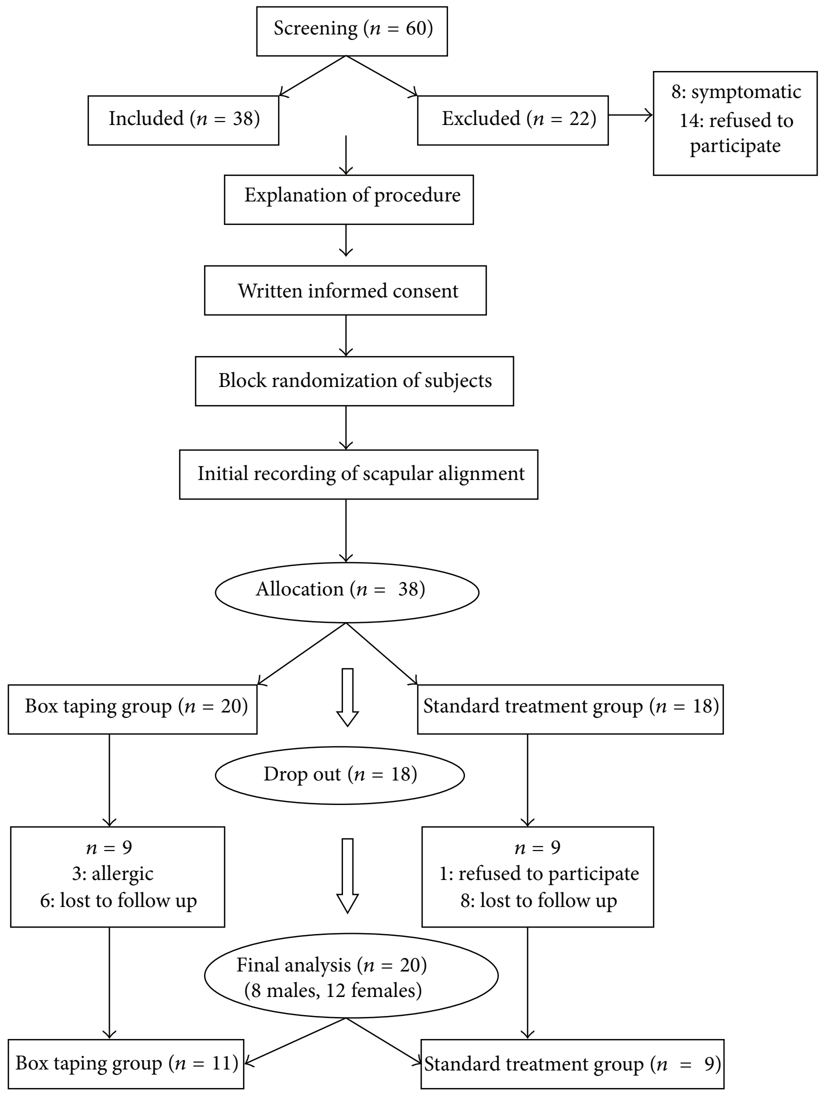

Figure 6: CONSORT diagram describing participant recruitment and retention.

Table 2: Mean difference [95% CI] between two groups at baseline ($n = 20$).

Variable	Left		Right	
	Mean difference [95% CI]	P value	Mean difference [95% CI]	P value
		Static scapular alignment		
NSA ratio	−0.03 [−0.14, 0.08]	0.59	0.01 [−0.07, 0.10]	0.66
Acromial distance (cm)	1.20 [−0.18, 2.60]	0.08	0.62 [−0.57, 1.81]	0.28
T 3 distance (cm)	0.13 [−0.85, 1.12]	0.78	0.47 [0.50, 1.45]	0.32
		Dynamic scapular alignment (LSST)		
0 degree	0.02 [−1.18, 1.22]	0.97	−0.04 [−1.2, 1.12]	0.94
45 degree	0.44 [−1.85, 0.95]	0.50	0.03 [−1.39, 1.45]	0.96
90 degree	0.15 [−2.00, 1.69]	0.86	0.15 [−2.00,1.69]	0.86

NSA ratio: normalised scapular abduction ratio.
T 3 distance: distance from medial scapular border to 3rd thoracic spine.
LSST: Lateral Scapular Slide Test.

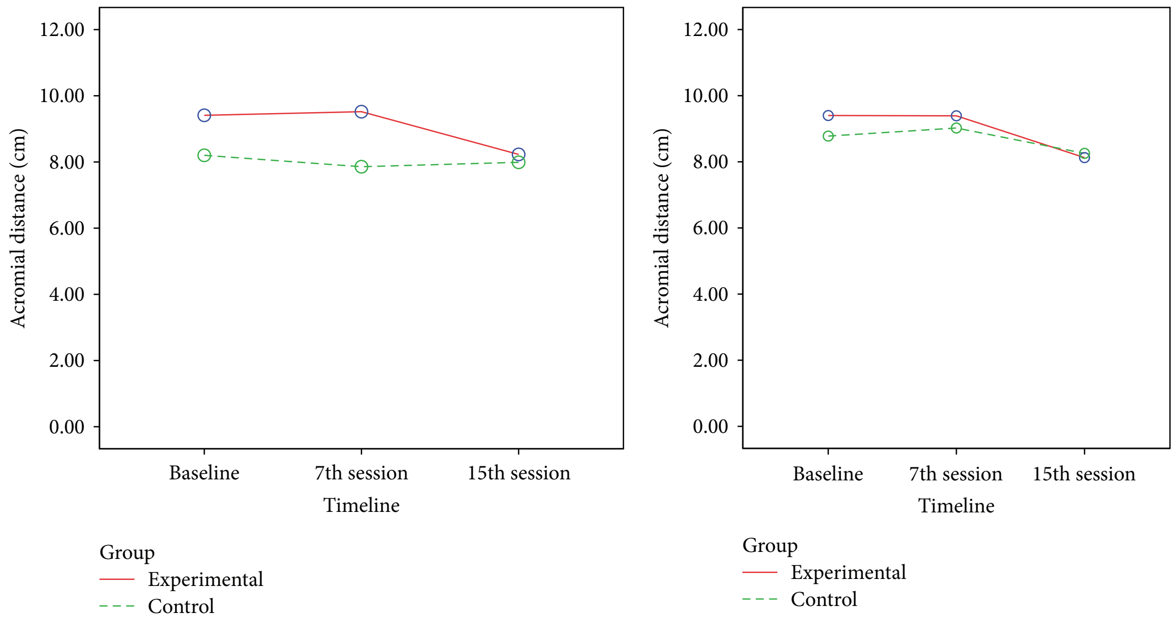

Figure 7: Changes in acromial distance: left and righ at baseline (1), 7th session (2), and 15th (3) session.

Table 3: Scapular alignment measurements of the Experimental group (mean ± SD) $n = 11$.

Variable	Left			Right		
	Baseline	7th session	15th session	Baseline	7th session	15th session
			Static scapular alignment			
NSA ratio	1.56 ± .15	1.51 ± .12	1.47 ± .07	1.67 ± .10	*1.56 ± .08	†‡1.50 ± .08
Acromial distance (cm)	9.40 ± 1.53	9.51 ± 1.25	†‡8.22 ± 1.32	9.40 ± 1.23	9.39 ± 1.23	†‡8.12 ± 1.46
T 3 distance (cm)	6.30 ± 1.06	6.63 ± 1.36	5.80 ± 1.24	6.86 ± 1.00	6.66 ± 1.09	6.22 ± 1.05
			Dynamic scapular alignment (LSST)			
0 degree	7.90 ± 1.02	8.02 ± 1.09	8.18 ± 1.32	7.68 ± 1.16	8.11 ± .93	8.18 ± 1.36
45 degree	7.77 ± 1.29	8.09 ± 1.64	8.40 ± 1.46	7.86 ± 1.45	8.22 ± 1.57	8.20 ± 1.26
90 degree	8.45 ± 2.09	8.59 ± .76	8.54 ± 1.09	8.54 ± 2.30	8.63 ± 1.05	8.50 ± 1.13

* *P* value significant between baseline and 7th session.
† *P* value significant between 7th and 15th session.
‡ *P* value significant bet baseline and 15th session.
NSA ratio: normalised scapular abduction ratio.
T3 distance: distance from medial scapular border to 3rd thoracic spine.
LSST: Lateral Scapular Slide Test.

decrease and hence improved in box taping group from baseline to last session (Table 3) (Figure 7).

3.2. Dynamic Scapular Alignment. Following commencement of treatment, there is no regular trend towards improvement in distances for LSST at 0 deg, 45 deg, and 90 deg (both sides) in both the groups which could be the reason for no statistical significant difference between as well as within the two groups (Tables 3 and 4).

4. Discussion

Optimal posture provides both mechanical and functional benefits [57]. If body segments are held out of alignment for prolonged periods of time, the soft tissues become shortened or lengthened [14] which inevitably results in altered optimal joint range, force production, and the efficiency of movement. Poor scapular posture and muscle imbalance has been postulated as a mechanism in pathogenesis of various upper quarter dysfunctions. The aim of many conservative rehabilitation programs is to correct posture and muscle imbalance using muscle strengthening, muscle stretching, taping, and joint mobilization techniques [13, 31, 42]. The evidence to support the efficacy of these clinical practices is limited. The application of taping has been hypothesized for many therapeutic reasons such as muscle recruitment [44, 58–60], proprioception [55], pain relief [39, 42, 61], and improvement of function [61] and it was thought to be necessary to demonstrate that one of the effects of taping, as used in this study, is to elicit a change in the static and dynamic posture of the subjects.

Table 4: Scapular alignment measurements of the control group (mean ± SD) $n = 9$.

Variable	Left			Right		
	Baseline	7th session	15th session	Baseline	7th session	15th session
			Static scapular alignment			
NSA ratio	1.59 ± .07	*1.49 ± .08	‡1.47 ± .09	1.65 ± .08	*1.53 ± .08	†‡1.45 ± .08
Acromial distance	8.20 ± 1.40	7.85 ± 2.75	7.98 ± 1.21	8.77 ± 1.30	9.02 ± 1.27	8.25 ± 1.04
T 3 distance (cm)	8.61 ± 1.78	5.77 ± .83	8.33 ± 1.25	8.16 ± 1.58	5.68 ± .80	8.49 ± 1.30
			Dynamic scapular alignment (LSST)			
0 degree	7.88 ± 1.53	7.22 ± 1.60	7.66 ± 1.27	7.72 ± 1.30	7.30 ± 1.43	7.83 ± 1.25
45 degree	8.22 ± 1.69	7.55 ± 1.64	7.61 ± 1.61	7.83 ± 1.58	6.74 ± 2.72	†7.77 ± 1.60
90 degree	8.61 ± 1.78	7.61 ± 1.49	8.33 ± 1.25	8.16 ± 1.58	7.42 ± 1.57	8.49 ± 1.30

**P* value significant between baseline and 7th session.
†*P* value significant between 7th and 15th session.
‡*P* value significant between baseline and 15th session.
NSA ratio: normalised scapular abduction ratio.
T 3 distance: distance from medial scapular border to 3rd thoracic spine.
LSST: Lateral Scapular Slide Test.

4.1. Static Scapular Alignment. In our study, although we were underpowered to detect significant differences between the two groups at $P < 0.05$, participants of both groups have shown statistically significant change in acromial distance and NSA ratio. Acromial distance is one of the reliable outcome measures for measuring static scapular alignment specifically in healthy forward shoulder posture [53] and has shown a stronger trend towards improvement in box taping group than in standard treatment group (Figure 7). This change in postural measurement can be attributed to a change in static posture of the subject, produced by the subject and further maintained by the tape.

Changes observed in static scapular alignment in our study are similar to results found in a cross-over study done by Lewis et al. [41] where the changes observed were within the wash-out period of one hour and the author recommended future studies to see the long-term effects of scapular taping. In comparison, 15 sessions of taping were given in our study with the tape being applied for 4 hrs/session, which might have resulted in greater correction. This is in accordance with Hall who suggested that up to two or three weeks of scapula taping may be necessary to improve neuromuscular control [62]. The results of our study showing improvement in static scapular alignment were also seen in a study done on effect of stretching and strengthening exercises given for six weeks in competitive swimmers with FSP [44].

The improvement in static scapular alignment was observed in all 20 subjects irrespective of the group in our study which is contradictory to previous studies where 6 weeks (3 times/week) of scapular muscle stretching-strengthening exercises did not find any improvement in static scapular alignment in FSP population [32, 33]. Factors which may have contributed to improvements in this study are the multimodal treatment which included strengthening of upper back musculature and thoracic spine mobilization in addition to scapular muscle stretching-strengthening exercises. Over and above, passive stretches were given with a hold of 30 seconds which is more intensive and preferable to previous studies [33] where stretches were given with only 10 seconds of hold.

4.2. Dynamic Scapular Alignment. The literature has shown that a minimum of six weeks of exercise is needed to show statistically significant strength gains [32, 33, 44]. For improvement in dynamic scapular alignment, the scapular muscles must be strong enough to stabilize scapula on the thorax and must have sufficient motor control to optimize the goal of dynamic stability. Reinforcing coordinated glenohumeral motion should help to improve altered scapulohumeral rhythm. The lack of improvement in dynamic scapular alignment in our study indicates that the exercise programme, though vigorous and supervised and given over a period of three weeks, was insufficient in comparison to unsupervised moderate intensity exercise programme given for six weeks [32, 33]. This highlights that while dosing exercise, we must consider the type, supervision, frequency, and duration of exercise.

The assumption is that taping provides biofeedback and mechanical support for optimal shoulder position. Both the type and duration of biofeedback for optimal posture from taping are different than that provided by advice and exercise. Greater duration of feedback from application of taping should have potential beneficial effect allowing adaptation of neural pathways by consistent correct proprioceptive feedback [63–65]. However, it is possible with repeated applications of scapula taping that the habituation to the feedback from tape may reduce the effectiveness of the feedback. Since increasing the tonic muscle action directed at optimal posture may be a goal of the intervention, then it is important to know whether taping facilitates or inhibits muscle activity in the longer term.

Furthermore, no statistically significant change is observed even when taping was used as an adjunct over a duration of three weeks in overall subject population. This is in support with the literature which has proved that at least 12 weeks of taping may be necessary to affect muscle tension properties in comparison to three weeks of treatment used in the present study [62]. We have used non elastic leukotape for scapular taping. However, other types of taping include kinesiotaping which may have different effects on muscle activity. Future studies with longer duration of high quality tape are needed to see long term effects of box-taping on dynamic scapular alignment.

We conducted measurements of both shoulders in our study. The process revealed interesting data showing more improvement on right side which could be related to hand dominance as all 20 subjects included in the study were right handed or could be due to the fact that subjects included in the study were fourteen right sided, two left sided, and four bilateral FSP subjects. This is a different approach from previous research involving shoulder measurements to evaluate posture, which typically evaluated only one shoulder on each subject, usually the right shoulder [33, 34].

Although this study suggests that the exercise and postural advice program was beneficial in improving posture in the healthy populations who were perceived to be at risk for musculoskeletal problems due to FSP. However, there are a number of limitations that should be considered as limiting our confidence in these findings or their readiness for implementation. There were substantial designs flaws since the trial did not have concealment of treatment allocation, or blinded outcome evaluation. Since blinding of patients was not possible, it would have been preferable if a blinded evaluator had been used to measure the outcomes. However, the measures were at different time points and the treating therapist was unaware of the previous scores. Further, it is unlikely that the treating therapist would have influenced measures like dynamic posture. This potentially reduces the impact of observer bias. There is a need for more research establishing reliable and valid outcome measures for scapular assessment in FSP population.

From an implementation perspective, there were additional concerns which were reflected in a high drop-out rate. Reasons for discontinuing the treatment included allergic reactions with use of leukotape and lack of interest in continuing. The motivation to adhere to treatments that are preventative may be more challenging than those provided to reduce symptoms as the motivation may be low. Finally, since this study recruited a small healthy sample of convenience derived from a single university campus, this precludes generalization of the results beyond the sample population. However, the rate of FSP was high as 50% of those who were screened had FSP. Given that the activities of students involve a lot of sitting, computer work, reading, and so forth they may be considered a young at-risk population and an appropriate target for prevention. Since symptoms may take time to develop, a young population may not have experienced the adverse impacts of this posture. Future studies should focus on populations with higher risk for FSP associated with symptoms such as workers with higher risk occupations, or include a greater education component to explain why prevention is important in asymptomatic groups. Future studies should include measures of adherence, measure reasons for discontinuance, and should include comprehensive outcome assessment measured by a blinded assessor. Importantly, since the link between FSP and future musculoskeletal disorders is tentative, only longer term longitudinal studies will determine whether prevention programs that focus on FSP correction reduce the occurrence, disability, and time lost from work from musculoskeletal disorders.

Implications of the present study are as follows.

(i) Supervised stretching-strengthening exercise program alone or in combination with box-taping were well tolerated in healthy forward shoulder posture subjects for correction of scapular alignment; but adherence may be challenging in asymptomatic young individuals.

(ii) Supervised stretching-strengthening exercise program was effective ($P < 0.05$) in correcting scapular alignment in asymptomatic students presenting with FSP. Thus, supervised stretching-strengthening exercise program may be a useful preventive measure in reducing FSP which is considered an etiological factor in development of upper quarter musculoskeletal disorders.

5. Conclusions

Supervised stretching-strengthening exercise program with or without box-taping resulted in improvement in posture in healthy forward shoulder posture population. There were no significant additive effects of box taping.

Ethical Approval

The research study is approved by institutional review committee of Manipal College of Allied Health Sciences (MCOAHS) towards postgraduation in orthopaedic physical therapy dissertation.

Disclosure

The authors declare that there are no financial gains from the content of this research paper. (i) The research paper is presented as a paper at 9th Triennial Congress of International Federation of Societies for Hand Therapists (IFSHT) and 12th International federation of Societies for Hand Surgeons (IFSSH), New Delhi, India (2013, March 5). (ii) The research paper is presented as a poster at CPA Congress, Montreal (2013, May 25).

Conflict of Interests

The authors declare that they have no conflict of interests.

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