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Research Article

EFFECT OF KINESIOTAPING ALONG WITH KALTERNBORN MOBILIZATION IN PATIENTS WITH SUB ACUTE ADHESIVE CAPSULITIS

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A B S T R A C T

Background: Adhesive capsulitis is condition characterized by progressive loss of both active and passive range of motion with potential of spontaneous resolution in 3 years. It is common in age group of 40-65 years. Many studies have shown the effect of kinesiotaping on adhesive capsulitis alone but there is lack of literature which prove that if kinesiotaping given along with mobilization will show any early recovery in patient with adhesive capsulitis. Thus there is need to see is there any effect of kinesiotaping along with kalternborn mobilization in in patients with sub acute adhesive capsulitis. **Methodology:** Two groups were taken, Group A received kalternborn mobilization and Group B received kinesiotaping along with kalternborn mobilization. Both groups received protocol for 3days/week for 4 weeks. **Result:** Statistical analysis shows improvement in VAS score, all shoulder range of motion and shoulder pain and disability index score in both groups at end of 2nd week and 4th week. But when compared between groups kinesiotaping along with kalternborn mobilization shown more improvement than kalternborn mobilization group alone

INTRODUCTION

The shoulder joint is ball and socket type of synovial joint and mobility of joint relies on congruent articular surfaces and dynamic stability by muscle around joint[1]. The position of humerus and scapula must change throughout each movement in order to maintain stability i.e. scapulohumeral rhythm [1,2]. If there is alteration in this movement due to some pathology causes shoulder pain. Shoulder dysfunction is 2nd most common musculoskeletal problems affecting the population. But every condition has its differentiating characteristics and different period of recovery[4,5]. It is common in age group of 40-65 years[5,6].

Adhesive capsulitis is condition characterized by progressive loss of both active and passive range of motion with potential of spontaneous resolution in 3 years[5,7] . The pain, stiffness and limited function of glenohumeral joint which adversely affects entire upper extremity. The incidence of adhesive capsulitis is 3-5% in general population and 20% in people with diabetes [6,7]. The progression of adhesive capsulitis commonly has 3 stages in which there is severe pain, gradual restriction in ROM and pain resolution and last phase causes the recovery of range of motion [8]

Glenohumeral capsule volume is less than 10ml which get reduced. According to study by J.S. Neviser he stated that absence of synovial fluid in glenohumeral joint leads to tightly contracted and thickened joint capsule.

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Cellular changes of chronic infiltration in synovial layer of capsule with reparative inflammatory process are pathological process of adhesive capsulitis [5]. There are two types of adhesive capsulitis Primary i.e. idiopathic which is insidious onset. The possible causes include immunologic, inflammatory, biochemical, and endocrine alterations and Secondary i.e. followed by trauma or surgery[5,8]. The three phases of adhesive capsulitis may not always recognizable in patients with secondary adhesive capsulitis.[5]

However, it is also known that limited glenohumeral movement leads to an increase in scapulothoracic movement. During the 3-dimensional kinematic analysis of scapular movements in adhesive capsulitis, increased external rotation and protraction of the scapula have been noted. The kinematic analysis of another study showed that there was significant impairment of humeral movements in patients with adhesive capsulitis in comparison to the control group. Such kinematic alterations cause a disruption in normal scapulothoracic rhythm.[9] The decreased glenohumeral ROM cause increased or compensatory scapulothoracic motions.[10,11]

According to Nicholson, during humeral elevation, increased upward translation of humeral head along with upward rotation of scapula had been reported in patients with adhesive capsulitis. Glenohumeral joint mobility decreases with scapular adhesions; this prevents external rotation of humeral head, and the humeral head slides below the acromion during humeral elevation[11]. In adhesive capsulitis, inferior fold of capsule becomes tight which restrict the superior rolling of humerus which causes shrug sign[11]. Due to this there is

increased activity of deltoid which is not counterbalance by rotator cuff muscles. This posture causes scapulothoracic muscle and shoulder muscle imbalance. Muscle imbalance and pain causes patients to attain slouched posture causing glenoid to move in downward rotated position, thus hanging arm is relatively in abduction on glenoid. This affects static stabilization due to which rotator cuff muscle come into action to maintain joint integrity.

There are many treatment protocols for adhesive capsulitis comprising of exercises, soft tissue massage, taping, different modalities, manual therapy like Kalternborn mobilization, Maitland mobilization, Mulligan mobilization for adhesive capsulitis

Mobilization is widely used to improve range of motion and reduce pain. One of them is Kalternborn mobilization, it can be use to increase range of motion and decrease pain by giving sustained stretch technique suggested by kalternborn. Kalternborn evaluates motion on articular surfaces and applies them to treatment according to concept of Kalternborn - Evjenth; Kalternborn mobilization involves application of passive sustained stretch technique to enhance joint mobility without articular surface suppression [13.14]. It also uses to relieve pain and reduce muscle spasm.. In adhesive capsulitis there is contracture of joint capsule which reduces range of motion. Anand Heggannavar stated that Kalternborn mobilization stretches tendon, ligament and capsule leads to improve physiologic accessory movements[16]. Hence by kalternborn mobilization by anterior and posterior translation of humeral head and stretching of capsule is helpful to increase range of motion [15,16].

But in recent years along with mobilization many other techniques are also used to give early recovery to patient and to relieve pain. In that now a days Kinsiotaping technique is used widely. Kinesiotaping was developed in 1990, by Kenzo Kase with intention to alleviate pain and improve healing of soft tissue. It is designed to mimic qualities of human skin [6,17]. Method of healing is based on simple principle that body has built in healing mechanisms and help to positively influence their efficiency by removing barriers that impede them. These results in increase fluid flow through injured area, better control over muscle contraction and fasten healing[17].

Mark D. Thelen *et al* (2008) in his research report suggested that Kinesiotaping can be helpful in improving pain free ranges immediately after application of tape and so helps in reducing disability.

Kinesiotape allows movements with corrected scapular alignment during shoulder movement improves glenohumeral motion and reduces micro trauma and mechanical irritation of soft tissue structures and reorient shoulder movements through arc of improved glenohumeral motion [19].

Hence according to study by Vermeulaun *et al*, kalternborn mobilization improves shoulder range of motion in adhesive capsulitis. Some studies have shown that kinesiotaping and conventional exercise program is also effective on adhesive capsulitis[18,19].

Need of Study

Many studies have shown the effect of kinesiotaping on adhesive capsulitis alone but there is lack of literature which prove that if kinesiotaping given along with mobilization will show any early recovery in patient with adhesive capsulitis which will help the patient to reduce pain ,increase range of motion in short period to improve the functional disability. This will help patient to recover as early as possible.

Thus there is need to see is there any effect of kinesiotaping along with kalternborn mobilization in early recovery in pain ,range of motion and functional disability in patients with subacute adhesive capsulitis

Research Question

Will kinesio taping as an adjunct with kalternborn mobilization is more effective as compare to kalternborn mobilization alone on pain, range of motion and functional disability in patients with subacute adhesive capsulitis?

Aim and Objectives

Aim

To find out the effect of kinesio taping as an adjunct with kalternborn mobilization and kalternborn mobilization alone on pain, range of motion and functional disability in patients with subacute adhesive capsulitis.

Objective of the Study

1. To study the effects of kalternborn mobilization on pain, functional disability and range of motion in subacute adhesive capsulitis.
2. To study the effect of kinesio taping along with kalternborn mobilization on pain, functional disability and range of motion in subacute adhesive capsulitis.
3. To compare the effect of kinesio taping along with kalternborn mobilization and kalternborn mobilization alone on pain, functional disability and range of motion in subacute adhesive capsulitis.

Hypothesis

- ***H_0 H_1 (Null)*** *:* There will be no significant difference of kinesiotaping along with kalternborn mobilization as compared to kalternborn mobilization alone on pain, range of motion and functional disability in subacute adhesive capsulitis.
- ***H1(alternative)****:* There will be significant difference in the effect of kinesiotaping along with kalternborn mobilization as compared to kalternborn mobilization alone on pain, range of motion and functional disability in subacute adhesive capsulitis.

MATERIAL AND METHODOLOGY

Research design*:* Experimental study design
Study setting*:* Tertiary care centre
Place of study*:* Pune
Study population*:* Subject with subacute adhesive capsulitis.
Sample size*:* 40
Method of sampling*:* Purposive Sampling
Duration of study*:* One year six month

Inclusion criteria

1. Age 40-60 years.[5][10]
2. Both genders.
3. Individuals with restriction of movements in capsular pattern. [1][12][43]
4. Primary type of adhesive capsulitis.[25][29][43][44]
5. subacute stage of adhesive capsulitis.[45][44]

6. Patients with minimum of grade 3 muscle strength

Exclusion criteria

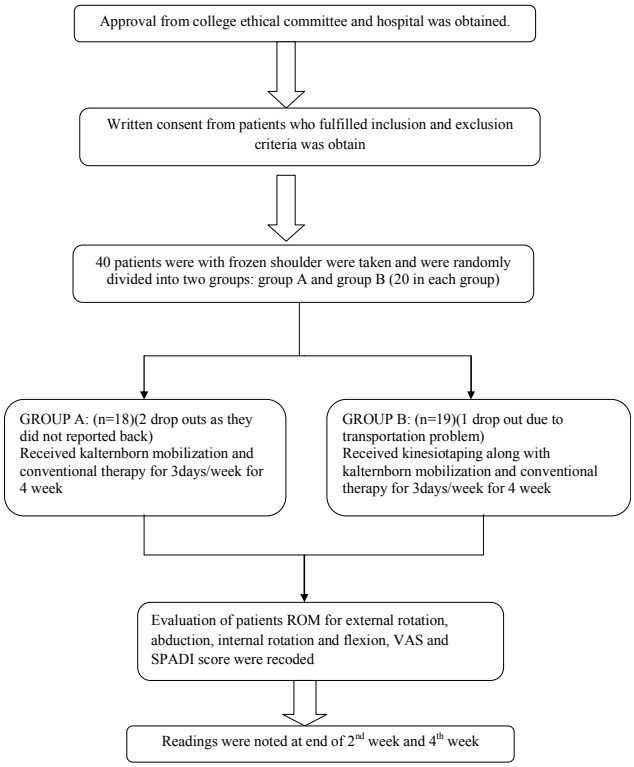
1. History of shoulder dislocation.[46]
2. Shoulder fractures(in past 1 year) [44][29]
3. Concomitant cervical spine symptoms [45][28]
4. Past shoulder surgery [29]
5. History of neurological condition (e.g.: stroke, parkinsons)[29][44]
6. Individuals with hypersensitivity to tape.[17][18]
7. Individuals with uncontrolled diabetes[29]

Material Used

Material and equipment used

1. Paper
2. Pen
3. Hot pack
4. Goniometer
5. Manual therapy table
6. Dumbbells
7. Kinesiotape
8. Scissor

Project Layout



Intervention

Conventional treatment

- Both group received conventional treatment and kalternborn mobilization.
- 4week protocol was given.

Hot pack

Patient will be in supine lying position. Hot pack will be wrapped in towel and will be applied over shoulder region for 15 min.[13,9,]

Active assisted ROM exercises for shoulder

Active assisted ROM exercises consist of flexion, horizontal abduction adduction, internal and external rotation using wand.

- For shoulder flexion: the wand is held with hand with shoulder in wide position. The wand is lifted through the available range with elbows kept in extension.
- For shoulder horizontal abduction and adduction: the wand is lifted to 90 deg flexion. Keeping elbows in extension the patient pushes and pulls wand back and forth across chest through available range.
- For internal and external rotation: the patient in supine position. The patient's arm is at sides and elbows are flexed to 90degree. Rotation of arm was accomplished by moving wand from side to side across the trunk while maintaining elbows at side.
- AROM exercise 10 repetition 2times/ day for 2 weeks.
- After 2 weeks 10repetition 2 sets 2times/day.[46]

Strengthening exercises for shoulder and scapular muscles

- On day 1 all patients were asseseed for MMT of shoulder and scapular muscles and those patients with muscle power grade 3 were excluded from the study.
- Shoulder and scapular strengthening exercise will be given as per D.A.P.R.E (daily adjustable progressive resisted exercise) program with Dumbbell or weight cuffs
- It is daily adjustable progressive resistance training that provides more objective approach to resistance exercises.
- The basis of program is 6 RM (repetition maximum)
- Regimen entails 4 lifting bouts of each exercise per session subsequent increase are determined by number of repetition performed in set 3.
- Once 1 RM is found 6RM can be calculated by dividing 1RM by 1.20
- If 10 RM is calculated then 6RM can be calculated by multiplying 10 RM by 1.36
- Determine initial working weight (6RM)

Perform

- Set 1 = 10 reps at 50% 6 RM
- Set 2= 6 reps at 75% 6 RM
- Set 3 = as many reps as possible with full 6RM
- Set 4 = as many as repetition possible with adjusted weight (this weight is based on number of repetition completed with full working weight in set 3
- The number of repetitions performed during the third set is used to determine the adjusted working weight for the fourth set, according to the guidelines in the next table.[47]

Adjustment to working weight

No. Of repetition during set 3	For set 4	For next day
0-2	Decrease by 5-10 lbs	Decrease by 5-10 lbs
3-4	Decrease by 0-5 lbs	Keep weight same
5-7	Keep weight same	Increase by 5-10 lbs
8-12	Increase by 5-10 lbs	Increase by 5- 15 lbs
13+	Increase by 10-15 lbs	Increase by 10-20 lbs

For shoulder flexors

Patient in sitting or supine. Using free weight cuff ask the patient to do forward flexion.[46,47]

For shoulder abductors

Patient was in sitting or standing with a weight in hand. The patients were asked to abduct the arm to 90^0 and then laterally rotate and elevate the arm through the rest of the range[46].

For external rotators

Patient in prone position with shoulder 90^0 flexed, elbow flexed with forearm over the edge of the table. Lift the weight as far as possible by rotating the shoulder, not extending the elbow. [46]

For internal rotators

Side-lying on the involved side with the arm forward in partial flexion. The patients were asked to lift the weight upward off the table into internal rotation. [46]

For shoulder extensor

Prone with the arm over the side of the table in 90^0 flexion. The patients were asked to lift the weight and extend the shoulder. [46]

For extensor

Patient in prone lying with involved arm at side in 90^0 of flexion (arm hanging) holding dumbbells. The patients were ask to do shoulder extension.[47]

Strenghtening of Scapular Muscles

For Rhomboids and Middle Trapezius (Scapular Retractors)

Patient in prone position with arm over the edge of table in dependent position and weight in hand. Patients were instructed to pinch scapulae together.[47]

For lower trapezius, infraspinatus, and teres minor and deltoid

Patient in prone with shoulder in 90^0 of abduction and externally rotated, and elbow flexed .Weight is placed in patient's hand and instructed to lift the arm few degrees off the table [47].

For Serratus anterior

Supine with arm flex to 90^0, slightly abducted and elbow extended. Weight was placed in hand and were instructed patients to push weight upward without rotating body.[47.]

Stretching exercise

Capsular Stretching exercises

- All the stretching and active assisted exercises were explained and demonstrated to patients and were performed by patients under supervision in first session and then asked patients to do it at home.
- Stretching was done to point of mild discomfort, holding each stretch for 30second once daily for 3 repetition.

For posterior capsule

Patient was in sitting position and asked patient to touch the opposite shoulder and over pressure was be given by other hand [28]

For inferior capsule

Patient was in standing position and asked to take involved arm overhear with elbow bent and with help of other hand arm was stretched further overhead [6].

For anterior capsule

Patient was in standing and instructed patients to take the arm into 90^0 abduction and external rotation and extension. The patients were to touch the wall and hold that position [28]

Kalternborn Mobilisation

GH caudal glide (for abduction)

Patient position: supine with arm in resting position and support the forearm between trunk and elbow.

Resting position: shoulder abducted 55^0, horizontally adducted 30^0 and rotated so forearm was in horizontal position.

Hand placement: One hand of therapist will be near axilla to provide grade 1 distraction and web space of mobilizing hand was just distal to acromion process [13,14]. The mobilizing force was applied in inferior direction and parallel to treatment plane.

Progression of caudal glide (for shoulder near 90^0)

Patient position: supine with arm abducted to the end of its available range. External rotation of humerus was added to end range position as arm approached beyond 90^0

Hand placement: stand facing patient's feet and stabilize patient's arm against therapist trunk with hand far from patient. Web spaces of other hand was placed just distal to acromion process on proximal humerus. And humerus was glided in inferior direction.[13,14]

To increase abduction beyond 90^0

Patient position: in sitting with resting position of shoulder abducted and externally rotated to the end of its available range.

Hand placement: same as for progression of caudal glide. One hand grasping elbow applies distraction. Mobilizing force was with hand on proximal humerus, glide humerus in progressively antero-inferior folds of capsule in axilla.

GH posterior glide (for flexion and internal rotation)

Patient position: Supine with arm in resting position.

Hand placement: Therapist will stand between the patient trunk and arm. Support the arm against trunk of therapist grasping distal arm with lateral hand to provide grade 2 distractions. And place lateral border of other hand just distal to anterior margin of joint with fingers pointing superiorly. Humeral head was glided posteriorly by moving entire arm as you bend knees.

The mobilizing force was in posterior direction and perpendicular to treatment plane[13,14]

Progression of posterior glide

Patient position: supine with shoulder 90^0 flexed, internally rotated and with elbow flexed.

Hand placement: Towel padding was placed under scapula for stabilization. One hand of therapist across the proximal surface of humerus to apply grade I distraction. Other hand was over

patient's elbow. Humerus was glided posteriorly by pushing down at elbow through long axis of humerus.[2]

GH Anterior Glide (For External Rotation And Extension)

Patient position: prone with arm in resting position over edge of treatment table supporting on therapist thigh .stabilize acromion with padding.

Hand placement: therapist was in forward stride position. Supporting patient's arm against therapist thigh. Ulnar border of hand was placed just distal to posterior to acromion process with fingers pointing superiorly. . Gliding humerus in anterior and slight medial direction. [13,14]

- Grade I distraction were given to all patients.
- Then grade II mobilization were given and as per the patients progress it was progressed to grade III.
- The stretch is held for five to seven seconds and slowly released back. The procedure is repeated for 3-4 times at 3-4 sec of intervals. [8]
- Further after two weeks procedure is repeated for 5-6 times.
- Duration - 30min duration will be taken for per session[8]
- Frequency - Each session will be done 3 times / week[13,14,2]

For Group B

This group received kinesiotaping along with kalternborn mobilization and conventional therapy same as group A.

Following instruction given to patients

- The skin should be free of oils and lotions and should be cleaned prior to tape application.
- To remove tape from patients skin much easier to do when tape is wet
- Best to remove from top to down in direction of body hair and should limit discomfort
- Lift tape from skin applying tension between skin and tape then push skin away from tape rather than pulling tape away from skin. .[17]
- Patient can ware tape for several days and can be worn while bathing or swimming.[17,48]
- The tape does not have to be removed if it has become wet only towel off excessive moisture and allow to air dry.[17,48]

Application of tape

- Kinesio tape was applied for deltoid and supraspinatus in muscle technique and scapular taping was done in corrective technique.
- Muscle technique

For Supraspinatus

Patient in sitting with neck lateral flexed position and arm was adducted and internally rotated. Y shaped strip of tape was used base is just below the greater tubercle of humerus.[17,19,29,48]. One tail of that tape was applied superior to spinous process of scapula end in supraspinous fossa and other tail along the spinous process of scapula[48].

For Deltoid

It was applied from insertion to origin and Y shaped strip was used.

Patient in sitting position

- The base of kinesiotape Y strip was 2 inches below the deltoid tuberosity of humerus with no tension
- For anterior deltoid one strip was applied with patients arm in horizontal abduction and external rotation and horizontal extension
- For posterior deltoid another strip is applied with patients arm maintaining adduction horizontal flexion and internal rotation[17,19,29,48]

Scapular taping

Scapula was taped in corrective technique.

- Patient in standing position. Base of tape was between interscapular region and patient was asked to retract shoulder [29].and both the ends were applied.
- Tape was applied twice week. For 4 weeks[17,29,4]

Statistical Analysis

The baseline characteristics between the groups were compared to maintain uniformity between the groups. Normality test was applied to see the data normality of data so that baseline parameters are comparable.

ANOVA test was used to find out the significant difference for VAS, range of motion and SPADI from day 1, after 2 weeks and after 4th week of intervention within the groups. Unpaired 't' test was used to find out the significant difference for VAS, range of motion and SPADI between the groups.

For all the tests level of significance was set at p equal to or less than 0.05.

Table 1 Comparison of Group A and Group B within and between the groups for VAS

	Group A		Group B		Values		Inference
	Mean	SD	Mean	SD	t value	p value (between group)	
Day 1	65.44	11.06	68.05	10.48	0.825	0.414	Not significant
2nd week	53.55	11.19	42.68	13.27	2.685	0.011	Significant
4th week	41.61	12.93	24	10.39	4.518	0.0001	Significant
f value	36.95		141.95				
p value (between group)	0.0001		0.0001				

Inference: There is no significant difference in VAS in both the groups (p=0.414, p>0.05) .In within the group analysis significant improvement in VAS noted from day 1 to end of 4th week in both the groups (p=0.0001,p<0.05). However it can be noted that in between the group analysis the improvement in VAS in group B was better at end of 2nd week (p =0.011,p<0.05) which further improved at end 4th week seen as compared to group A.(p=0.0001,p<0.05)

Table 2 Comparison of Group A and Group B within and between the groups for flexion

	Group A		Group B		Values		Inference
	Mean	SD	Mean	SD	t value	p value	
Day 1	91.55	7.64	93.68	9.2	1.076	0.289	Not Significant
2nd week	109.5	11.02	127.68	13.74	4.42	0.0001	Significant
4th week	122	11.83	139.42	16.7	3.63	0.0009	Significant
f value	82.17		107.21				
p value	0.0001		0.0001				

***Inference**:* There is no significant difference between the average score of active range in group A and group B on day 1(p=0.298,p>0.05) In within the group analysis there was significant improvement in flexion range noted from day 1 to end of 4th week in both the groups (p=0.0001,p<0.05). However it can be noted that in between the group analysis improvement in flexion range in group B was better at end of 2nd week (p =0.0001,p<0.05) which further improved at end 4th week seen as compared to group A.(p=0.0009,p<0.05)

Table 3 Comparison of Group A and Group B within and between groups for Abduction

	Group A		Group B		Values		Inference
	Mean	**SD**	**Mean**	**SD**	**t value**	**p value (between group)**	
Day 1	77.94	12.21	80.42	10.18	0.671	0.506	Not significant
2nd week	99	15.11	113.84	13.78	3.123	0.003	Significant
4th week	113.05	11.83	129.15	15.41	3.543	0.001	Significant
F value	64.28		51.00				
P value (within group)	0.0001		0.0001				

***Inference**:* There is no significant difference between average abduction range of group A and group B on day 1(p=0.506,p>0.05) In within group analysis significant improvement in abduction range noted from day 1 to end of 4th week in both the groups (p=0.0001,p<0.05). However it can be noted that in between group analysis improvement in abduction range in group B was better at end of 2nd week (p =0.003,p<0.05) which further improved at end 4th week seen as compared to group A.(p=0.001,p<0.05)

Table 4 Comparison of Group A and Group B within and between the groups for external rotation

	Group A		Group B		Values		
	Mean	**SD**	**Mean**	**SD**	**t value**	**p value(between group)**	**Inference**
Day 1	23	6.37	21.57	7.02	0.643	0.524	Not significant
2nd week	36.27	6.9	43.21	8.4	2.722	0.013	Significant
4th week	46.67	8.23	55.21	8.7	3.062	0.004	Significant
f value	96.51		169.23				
p value(within group)	0.0001		0.0001				

***Inference**:* There is no significant difference between mean of external rotation score of group A and group b on day1 (p=0.524,p>0.05). In within group analysis significant improvement in external rotation range noted from day 1 to end of 4th week in both the groups (p=0.0001,p<0.05).

Table 5 Comparison of Group A and Group B within and between the groups for internal rotation

	Group A		Group B		Values		
	Mean	**SD**	**Mean**	**SD**	**T value**	**P value (between group)**	**Inference**
Day 1	24.5	7.27	24.84	7.44	0.141	0.884	Not significant
2nd week	38.33	7.4	44.36	8.9	2.216	0.003	Significant
4th week	48.12	9.08	56.89	8.37	3.061	0.004	Significant
F value	78.92		141.87				
P value(within group)	0.0001		0.0001				

However it can be noted that in between group analysis improvement in external rotation range in group B was better at end of 2nd week (p =0.013,p<0.05) which further improved at end 4th week seen when compared to group A.(p=0.004,p<0.05)

***Inference**:* There is no significant difference between internal rotation range of group A and group B on day1 (p=0.884,p>0.05). In within group analysis significant improvement in internal rotation range noted from day 1 to end of 4th week in both the groups (p=0.0001,p<0.05). However it can be noted that in between the group analysis improvement in internal rotation range in group B was better at end of 2nd week (p =0.03,p<0.05) which further improved at end 4th week seen as compared with other group.(p=0.004,p<0.05)

Table 6 Comparison of Group A and Group B within and between the groups for pain score of SPADI

	Group A		Group B		Values		Inference
	Mean	**SD**	**Mean**	**SD**	**T value**	**P value (between group)**	
Day 1	70.67	8	74.05	9.9	1.135	0.264	Not significant
2nd week	54.78	6.5	46.84	12.49	2.403	0.021	Significant
4th week	42.37	7.19	27.84	11.18	4.658	0.0001	Significant
F value	135.51		159.87				
P value(within group)	0.0001		0.0001				

***Inference**:* There is no significant difference between pain score of SPADI of group A and group B on day 1(p=0.264,p>0.05).In within group analysis significant improvement in pain score of SPADI noted from day 1 to end of 4th week in both the groups (p=0.0001,p<0.05). However it can be noted that in between group analysis improvement in pain score of SPADI in group B was better at end of 2nd week (p =0.021,p<0.05) which further improved at end 4th week seen when compared to group A.(p=0.0001,p<0.05)

Table 7 Comparison of Group A and Group B within and between the groups for disability score of SPADI

	Group A		Group B		Values		Inference
	Mean	**SD**	**Mean**	**SD**	**T value**	**P value (between group)**	
Day 1	79.38	8.11	78.47	7.56	0.356	0.723	Not significant
2nd week	54.78	6.5	46.84	12.49	2.403	0.021	Significant
4th week	42.37	7.19	27.84	11.18	4.658	0.0001	Significant
F value	123.16		224.75				
P value(within group)	0.0001		0.0001				

***Inference**:* There is no significant difference in disability score of SPADI of both groups on day 1(p=0.723,p>0.05). In within group analysis significant improvement in disability score of SPADI noted from day 1 to end of 4th week in both the groups (p=0.0001,p<0.05). However it can be noted that in between group analysis improvement in disability score of SPADI in group B was better at end of 2nd week (p =0.021,p<0.05) which further improved at end 4th week seen when compared with group A (p=0.0001,p<0.05).

Table 8 Comparison of Group A and Group B within and between the groups for total score of SPADI

	Group A		Group B		Values		Inference
	Mean	SD	Mean	SD	T value	P value (between group)	
Day 1	74.95	6.6	77.47	5.3	0.767	0.448	Not significant
2nd week	59.39	6.5	51.73	8.80	2.992	0.005	Significant
4th week	46.78	5.38	36.78	10.45	3.621	0.0009	Significant
F value	197.57		218.41				
P value(within group)	0.0001		0.0001				

Inference: There is no significant difference between total score of SPADI of both the groups on day 1($p=0.448, p>0.05$). In within group analysis significant improvement in total score of SPADI noted from day 1 to end of 4th week in both the groups ($p=0.0001, p<0.05$). However it can be noted that improvement in total score of SPADI in group B was better at end of 2nd week ($p=0.005$, $p<0.05$) which further improved at end 4th week seen when compared to group. ($p=0.0009, p<0.05$).

DISCUSSION

In adhesive capsulitis there is loss of range of motion in all planes and pain persists for months. In subacute stage pain during movement of shoulder joint is more evident. The present study was conducted to see the effect of kinesiotaping as an adjunct to kalternborn mobilization in patient with subacute adhesive capsulitis on pain, range of motion and functional disability. Pain was measured on VAS scale, range of motion by goniometer and functional impairment was measured on shoulder pain and disability index.

The result of study stated that there is statistically significant improvement in VAS, range of motion and functional disability after 4 week protocol of both kalternborn mobilization alone and kinesiotaping along with kalternborn mobilization. The study also observed that on comparing 2 groups there was statistically significant difference in VAS, ROM and SPADI in group with kinesiotaping along with kalternborn mobilization at end of 2nd week and at the end of 4th week.

The age of participants was taken between 40-65 years in both the groups. The mean age of participants in group A is 54.83±4.31 years and in group B it was 53.05±5.02 years. There was no significant difference between the mean ages of both groups. Gender distribution of groups are 9 male and 9 female in group A and 10 male and 9 female in group B.

In present study there was significant reduction in pain in both kalternborn mobilization alone and kinesiotaping along with kalternborn mobilization groups.

The present study also showed improvement in functional disability of participants which was measured by shoulder pain and disability index (SPADI).

Along with kinesiotaping and kalternborn mobilization both groups received conventional treatment which included active assisted range of motion exercises, capsular stretching, hot packs, and joint mobilization. Where mobilization controls pain through neurophysiological effects by stimulating type II mechanoreceptors while inhibiting type IV nociceptors. It also provokes golgi tendon organ activity at end of joint mobilization and causes reflex inhibition of muscle.[53,54]. The decreased muscle activity after joint mobilization decrease joint concentric activation and alleviate pain. [53,54]

Pain relief have been result of additional benefit from kinesiotaping along with kalternborn mobilization in group B which works on simple principle that body has built in healing mechanism. By providing tactile cues and thus provide corrected position of scapula help to minimize fascial contraction during soft tissue injury. Kinesiotape has expanding and contracting properties which provides gentle sensory stimulation to various types of sensory receptors in skin during movement[29,62]. According to Mark D Thelan kinesiotape activates skin receptors as well as proprioception in skin during movement. This activates spinal inhibitory system through stimulation of touch receptors and activates descending inhibitory system to decrease pain via gate control theory proposed by Melzack and Wall and help to decrease pain,[18,29]

In adhesive capsulitis in subacute stage there is marked decrease in range of motion of shoulder joint in capsular pattern[63].

In present study there was significant improvement in range of motion both groups.

Thus showing that both groups were effective in increasing flexion, abduction, external rotation and internal rotation. But when kinesiotaping is used as an adjunct in group B the better improvement is seen in range of motion in all three planes.

According to Robert Marske *et al* in the second or subacute stage of adhesive capsulitis shoulder pain does not necessarily worsen but there is pain at end of ROM, use of arm is limited causing muscular disuse. This causes capsular pattern of limitation [45,65]. The primary role of mobilization to restore joint play and facilitate joint movement by restoring arthrokinematics. The sustained glide causes stretching of rotator cuff interval causing translation of humeral head, resulting in increase in range of motion .The neurophysiologic effect is based on stimulation of peripheral mechanoreceptors and inhibition of nociceptors. [54,65]

The biomechanical effect manifests itself when forces are directed towards resistance but within limit of patient's tolerance [5.] The mechanical changes may include breaking up adhesion in capsule, collagen realignment and improving interfibre glide when specific movement stress the specific part of capsular tissue [5,66 .] But group B which were treated with kinesiotaping shown more improvement in range of motion because in adhesive capsulitis there is over activation of deltoid and supraspinatus muscle. Kinesiotape was applied to deltoid to reduce passive tension caused due to prolonged fatigability and to supraspinatus to reduce tension due to prolonged elongation according to principle of Kenzo Kase[6],. This technique is used to inhibit muscle function to provide relaxation and for inducing rebounding proprioceptive feedback in opposite direction of contraction, thereby resulting in improvement of range of motion[.31,38].

While applying k-tape muscle stretch is given so it was hypothesized that through prolonged stress relaxation and viscoelsatic deformation will occur over period of time which will increase tissue extensibility. These increased extensibility can increase number of sarcomeres as adaptive change which

will rearrange the collagen and will increase mobility of joint.[67].

Yoshida *et al* found that there is increase in range of motion after application of Kt in which two mechanisms were explained for increased range of motion, first was the proponents of kinesio tape state that tape convolution areas may increase the flow of blood and lymphatic fluids due to a lifting effect, which creates a wider space between the skin and the muscle and interstitial space, The possible increase in blood circulation is theorized to affect muscle functions [38,69] . The second was stimulation of cutaneous mechanoreceptor which activates nerve impulses when mechanical load which include touch, pressure, vibration, stretch which create deformation. This activation of cutaneous mechanoreceptors by adequate stimulus causes local depolarization that trigger nerve impulse along afferent fiber travelling towards central nervous system mechanoreceptors.[38,62] .

This was also explained by Gonzalez Iglesias who stated that kinesiotape induced change in muscle tone could result from stimulation of mechanoreceptors which results in reflexive activation of motor units in same muscle that was source of neural stimulus. [68,70]. This two theories also supported by other two researcher Rafael Merino-Marban and Halseth *et al*., who studied effect of kinesiotaping on range of motion.

The fear of movement is associated with pain intensity in patients and so application of KT along with kalternborn mobilization provides sensory feedback that reduces fear of movement and thus increase range of motion was earlier than kalternborn mobilization alone which helped in early rehabilitation of patients with subacute adhesive capsulitis.

The main rationale behind better improvement in functional independence in group B receiving kinesiotaping along with kalternborn mobilization earlier i.e at end of 2nd week than kalternborn mobilization alone group, might be due to ease in pain and increased range of motion, consequently lessened suffering in daily activities, pain with specific tasks and difficulty in moving arm and lifting action[29]

The study done by Gui DO Moon *et al* proved that kalternborn mobilization technique help in improving shoulder pain and range of motion in adhesive capsulitis this supports our study.[13] The study done by Smita kanse *et al* stated that kinesiotaping is better in improving pain, range of motion and disability of patient with adhesive capsulitis than only conventional therapy and mobilization this study result support the results of our study.[29]

Thus it was observed that kinesiotaping as adjunct with kalternborn mobilization is effective in treatment of subacute adhesive capsulitis however kinesiotaping by inhibiting muscle over activation relieves pain, improves range of motion by increasing tissue extensibility and hence leads to improved functional disability. So in our study H1 alternative hypothesis was accepted.

CONCLUSION

In present study we conclude that four weeks of kalternborn mobilization alone and kalternborn mobilization along with kinesiotaping are effective in reducing pain, improving range of motion and decreasing disability. Improvement in all components was more significant in kinesiotaping along with kalternborn mobilization group earlier than (at end of 2nd week) than in kalternborn mobilization alone group.

Limitations

- Small sample size
- Follow up effect of treatment technique was not taken after 4 weeks.
- Previous history of adhesive capsulitis of shoulder was not taken into consideration.
- Both groups received strengthening for shoulder and scapular muscles but strength was not checked subjectively or objectively.

Scope of Future Study

- Kinesiotaping to different muscle like lower trapezius, serratus can be applied to see effect.
- Other manual technique along with kinesiotaping can be seen
- Prolonged effect of techniques can be seen.

Clinical Implication

Adhesive capsulitis is commonly seen condition among shoulder pain. There is fascial restriction, trigger points; muscular tightness results in pain and decreased range of motion causing some degree of disability in daily activities. Thus to overcome pain and increase range of motion physiotherapy treatment technique should be use. So for early recovery of patients kinesiotaping along with kalternborn mobilization and conventional therapy will be more useful to improve functional independence.

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