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Comparative effect of longitudinal taping versus California tri pull taping technique for shoulder subluxation in patients with acute stroke

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Abstract
Background: The subluxation of shoulder is the commonest complication in acute stroke patients in population. Neuromuscular weakness, changes in muscle tone and abnormal signals after acute stroke affect the biomechanics of scapula and shoulder complex resulting subluxation, pain, decrease in flexion and abduction range of motion. Therefore the present study aims to compare the effect of longitudinal taping versus California tri pull taping technique for shoulder subluxation in patients with acute stroke as assessed by NPRS, F-ROM, AB-ROM and subluxation.
Materials and Methods: A pre and post comparative study was done and 40 patients mean age group of 45-65 years were included in the study. Group A received longitudinal taping and Group B received California tri pull taping techniques respectively. NPRS, F-ROM, AB-ROM and subluxation measurement were taken before and after intervention. The intervention was given six times in two weeks. Data was analyzed by Paired and Unpaired t test.
Results: There was very significant difference (p<0.0001) in NPRS, F-ROM, AB-ROM and subluxation measurement values in group B compare to group A after 2 weeks of intervention.
Conclusion: The study concluded that Longitudinal Taping and California tri pull taping both showed significant improvements but California tri pull taping technique showed more effectiveness in improving subluxation as well as NPRS, F-ROM, AB-ROM values in subluxation patients after acute stroke.

Keywords: Stroke, NPRS, A-ROM, AB-ROM, shoulder subluxation, UT, LT

Introduction
The rapid development of clinical signs and symptoms of focal neurological disturbance lasting for more than 24 hours or leading to death with no apparent cause other than vascular origin clinically defined stroke by "World Health Organization" (WHO) [1]. Its a global health problem, second commonest cause of death and fourth leading cause of disability worldwide [2]. In developed countries, it is the first leading cause for disability and second leading cause of death [3]. About 1.25 times greater incidence in males then females of stroke [1]. The overall prevalence rate for stroke lies between 84-262 per 100,000 in rural area [4] and between 334-424 per 100,000 in urban areas [5], but about 10-15% of stroke occurs in people below age of 40 years have shown in Indian studies [6]. The inferior displacement of the humeral head from the glenoid cavity, a common secondary musculoskeletal impairment referred to as inferior shoulder subluxation after stroke [7]. The rate of shoulder subluxation post stroke varies with the occurrence as high as 81% [8]. The primary cause of shoulder subluxation after stroke is not known although many different reasons have been proposed as contributing to subluxation. These range due to compromised muscle activity around the shoulder joint, particularly in the supraspinatus, which decreases the stability of the shoulder joint to the effect of loading on the flaccid extremity, as well as increase's downward scapular rotation which possibly allows the head of the humerus to sublux inferiorly [9]. Hemiplegic patients with subluxation may experience shoulder pain, and about 5%-84% of shoulder pain is reported due to differing definitions of pain and patients selected. Many different factors have been found to contribute for shoulder pain [10] but still actual mechanisms for shoulder pain are not fully understood. Weakness of muscles around the

joint after stroke is believed to be a primary reason for shoulder pain. As the humeral head cannot be held in a proper position because shoulder muscles cannot contract effectively against gravity and external force during movement. Shoulder pain and subluxation with decrease in joint range of motion may be occurs with gradually stretched and torn soft tissues around the shoulder joint [11]. This is understanding constitutes a reasonable mechanism to explain why soft tissue injuries are usually observed in shoulder pain after acute stroke [12-15]. Other factors such as disturbed sensory and cognitive function are also proved to be involved in shoulder pain after acute stroke [16]. Regardless of the limited understanding of the etiology of shoulder pain after acute stroke patients, various therapeutic methods have been trialed to examine their effects on shoulder pain after acute stroke patients. To provide effective support to shoulder different (slings and strapping) methods are usually involved in the therapeutic strategy [17-18] but electrotherapy modalities with appropriate exercise program are also proved to be necessary for the treatment of shoulder pain [19-22]. However, evidence for the effectiveness of these conventional methods (sling, strapping) are limited for shoulder pain. Some of these treatment methods have significant problems and limitations to their use, which may limit the movement of the shoulder and interfere with the recovery of the functions [19, 22-23]. Taping use as a therapeutic modality by athletic trainers, physical therapists and other health care and sports professionals for injury prevention and rehabilitation [24]. Clinicians typically apply tape to mechanically restrict undesired joint motion while permitting or even facilitating, desired movement. A therapeutic benefit related to proprioception through increased tactile input has been proposed as another mechanism of action [25]. Two main variations of tape are available for clinical use: standard athletic tape (rigid adhesive tape applied over a joint to provide biomechanical support) [24] and elastic tape (stretchable adhesive tape, such as Kinesio Tape (Kinesio Holding Corp, Albuquerque, NM or Dynamic Tape (Posture Pals Pty Ltd, Port Vila, Vanuatu) [24]. Therapeutic taping techniques have demonstrated short term clinical effectiveness in managing some musculoskeletal shoulder conditions, including pain [26-29] and coordination of scapular muscles [30-32]. For example, decreased upper trapezius (UT) and increased LT activity were observed in individuals with shoulder-impingement syndrome after rigid tape was applied perpendicular to the muscle fibers to inhibit the UT [32]. After similar taping using Kinesio Tape, Lin *et al.* [33] demonstrated increased serratus anterior (SA) and decreased UT muscle activity and improved proprioception in healthy individuals. These findings may suggest changes in kinematic variables or neuromuscular control, including centrally mediated changes [34-35]. However, the mechanisms underpinning the benefits of tape are not well understood [36, 26, 34, 37]. The available current methods (slings, electrical stimulation, taping, strapping) of treatment none have demonstrated they are full effective to aligning the head of the humerus into the glenoid fossa, reducing pain, allowing for functional use of the arm, and maintaining equilibrium of upper limb. Two to three strips of strapping that are applied with a cephalad tension over the anterior, middle and posterior deltoid to end over the shoulder complex, sometimes with an anchor strip applied, known as longitudinal taping method. It is described or used in a range of studies (Chattergee *et al.* 2016; Hayner 2012; Kneeshaw 2002) [38-39]. More careful handling by the caregivers to use of this taping method on shoulder pain as increased awareness of the affected limb. It could also be considered that the strapping provided cutaneous stimulation through the large fibers (C-fibers), which would be introducing a competing sensation to pain and hence the perception that pain has decreased [40]. Furthermore, one could consider the decrease in shoulder subluxation in the longitudinally tapping participants to be a contributing factor to the better pain outcomes in the intervention group. The main role of longitudinal taping method could be attributed to decreasing pain, which in turn could influence tone positively. There have been limited reports of taping the shoulder to treat shoulder subluxation in the post stroke population and limited additional reports of taping to address the pain. In studies the method, placement and type of taping all are vary greatly [38]. Hayner [41] developed the California tri-pull taping method and found in a quasi-experimental study that participants showed significant increase in active range of motion, subluxation, ADL, but there was no significant changes in pain. Similar results in a ten subject AB design study found by Chatterjee *et al.* [42]. There was a significant improvement in shoulder subluxation and pain and a significant increase in active shoulder flexion range and motor activity of upper limb. In Hayner's [41] California taping method used three pieces of rigid tape, with a firm upward pull, to support the hemiplegic subluxed shoulder. All three pieces were applied from 1.5 inches below the deltoid tuberosity up to mid spine of the (posterior) scapula, two inches above the glenoid fossa (middle) and 1.5 inches above the clavicle (anterior). The numerical pain rating scale (NPRS) is commonly used valid and reliable tool to measure shoulder pain [43]. The universal goniometer is reliable and valid tool accepted universally to measure joint range of motion [44]. So the purpose of this study is to compare the effectiveness of longitudinal versus California tri pull taping technique for shoulder subluxation on improvement of degree of subluxation, pain and ROM in patients with acute stroke. The Longitudinal and California Tri pull taping techniques are commonaly used to treat musculoscketal and nueuromuscular disorders to restore the functions. Most of the studies carried out on stroke patients to reduce pain, to facilited muscle functions, protact joints and surrounding tissues for further trauma, whereas the effects of longitudinal and California Tri pull taping technique on subluxation patients after stroke has not been studied well. Therefore, the present study was aimed to find out the effect of longitudinal and California Tri pull taping technique on subluxation patients after stroke.

Methods

A pre and post comparative study of 40 patents (both male and female) using simple random sampling and allocation with coin method was done. Patients which were affected with subluxation after acute stroke aged between 45-65 years included according to inclusion and exclusion criteria. The intervention both longitudinal taping and California Tri pull Taping technique were given for six times in two weeks. The inclusion criteria for this study were both male and female patients with acute stroke, age group between 45-65 years, co-operative patients who follow the therapist instruction, shoulder flexion less than 60 degree, shoulder subluxation of minimum 7 mm from glenoid cavity to humeral head and exclusion criteria unable to follow commands /un-cooperative patients, severe aphasia that makes it difficult for patients to follow verbal instruction from therapist, any contracture of upper limb, history of pain or surgery in the upper limb in last 6 months, receiving any stimulant or relaxant medications (including anti-

spasticity and anti-convulsion medications, pharmacological injections), peripheral nerve injury in upper limb and skin allergy with tape.

Outcome measures

Universal Goniometer

The universal goniometer was used in the study for measuring active F-ROM and AB-ROM of the shoulder joint.

NPRS (Numerical pain rating scale)

The NPRS was used in the study to measure the pain.

Measurement tape (to measure the subluxation)

The measurement tap was used in the study to measure subluxation.

The study received approval from Institutional Ethical Committee Ref.no. KTG/CPT/IEC/2021/190 of KTG College of Physiotherapy Hegganahalli cross, Vishvaneedam post, Sunkudkatte, Bangalore.

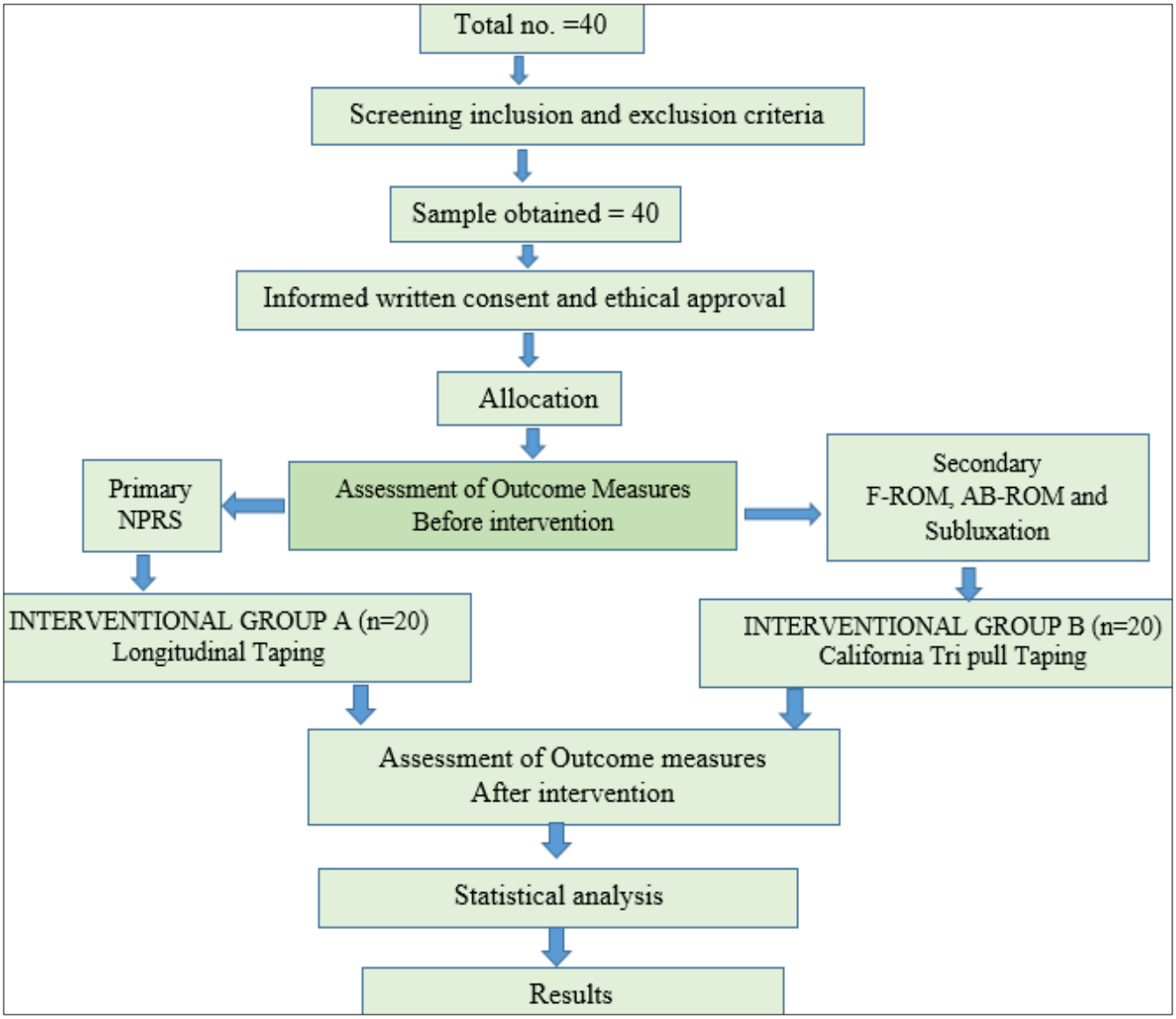


Fig 1: Flow chart representing the procedure of selection of patients

Results

Paired t test and unpaired t test were applied to analyze the data. All statistical analysis was done with utilizing the trial version of Graph Pad Instat software and $p<0.05$ is considered as level of significance.

NPRS

The mean difference in group A and group B after intervention was 1.5±0.52 and 2.7±1.7 respectively.

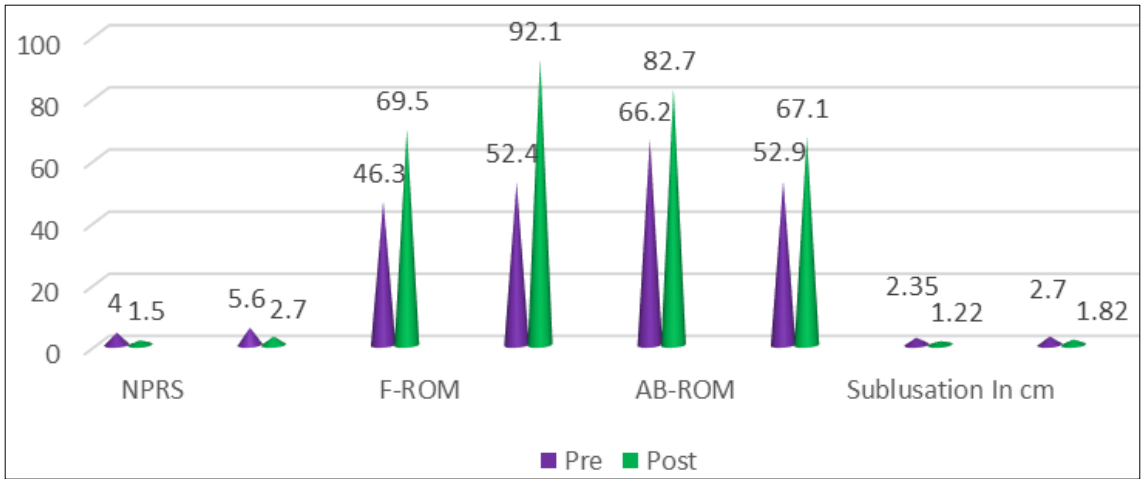
F-ROM: The mean difference in group A and group B after intervention was 70.5±22.05 and 92.1±18.0 respectively.

AB-ROM: The mean difference in group A and group B after intervention was 67.1±18.28 and 82.7±10.7 respectively.

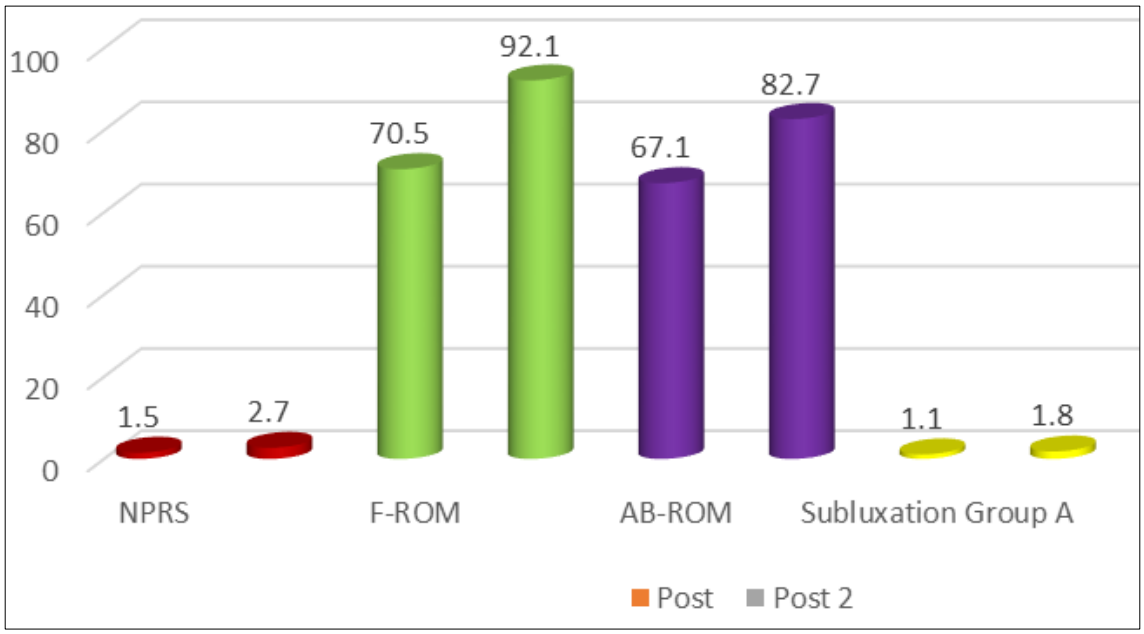
Subluxation cm: The mean difference in group A and group B after intervention was 1.1±0.45 and 1.82±0.87 respectively.

Table 1: Pre-Post and Mean Difference comparison of NPRS, F-ROM, AB-ROM and subluxation in both the groups

Parameters	Groups	Pre	Post	Mean difference	p-value	t-value
NPRS	Group A	4 ±1.70	1.5±0.5	1.5±0.52	0.0020	4.294
	Group B	5.6±1.6	2.7±1.7	2.7±1.7	0.0004	5.878
F-ROM	Group A	46.3±9.0	69.5±21.2	70.5±22.05	<0.007	5.009
	Group B	52.4±6.4	92.1±18.9	92.1±18.0	<0.0001	7.65
AB-ROM	Group A	66.2±12.3	82.7±10.7	67.1±18.28	<0.0001	7.745
	Group B	52.9±15.3	67.1±18.2	82.7±10.7	0.0021	4.265
Subluxation	Group A	2.35±0.81	1.1±0.45	1.1±0.45	0.0029	4.038
	Group B	2.7±0.94	1.82±0.87	1.82±0.87	0.0293	2.58



Graph 1: Pre and Post comparison of NPRS, F-ROM, AB-ROM and subluxation in both the groups



Graph 2: Mean Difference comparison of NPRS, F-ROM, AB-ROM and subluxation in both the groups

Discussion

The main purpose of this study was to determine the effect of Longitudinal and California tri pull taping technique on NPRS, F-ROM and AB-ROM in patients following subluxation after stroke. Most of the studies have focused on the use of Longitudinal and California tri pull taping technique in patients following subluxation after stroke but there are very less evidence of these techniques in patients following subluxation after stroke. Many studies support to use Longitudinal and California tri pull taping technique to reduce pain, improve motor function and increase functional ability of the limb. The result obtained in this study indicates that, there was highly significant difference in the NPRS, F-ROM and AB-ROM after two weeks of intervention.

NPRS (Numerical Pain Rating Scale)

The pre intervention mean value of NPRS in patients of group A (LTG Group) was 4 ±1.70 and after 2 weeks mean value of NPRS was 1.5±0.5. The differences between the pre and post values of PEFR in group A was 2.50.

Before the intervention of the mean value of NPRS in patients of group B (CTG Group) was 5.6±1.6 and after 2 weeks of intervention mean value of NPRS was 2.7±1.7.The difference between the pre and post values of NPRS in group A was 2.7. Students unpaired t test used between

group A and group B after 2 weeks revealed that was statistically significant difference between two groups.

F-ROM (Flexion range of motion)

The pre intervention mean value of F-ROM in patients of group A (LTG Group) was 46.3±9.0 and after 2 weeks mean value of F-ROM was 69.5±21.2. The differences between the pre and post values of F-ROM in group A was -23.20. Before the intervention of the mean value of F-ROM in patients of group B (CTG Group) was 52.4±6.4 and after 2 weeks of intervention mean value of F-ROM was 92.1±18.9.

The difference between the pre and post values of F-ROM in group A was -39. Students unpaired t test used between group A and group B after 2 weeks revealed that was statistically significant difference between two groups.

AB-ROM (Abduction range of motion)

The pre intervention mean value of AB-ROM in patients of group A (LTG Group) was 66.2±12.3 and after 2 weeks mean value of AB-ROM was 82.7±10.7. The differences between the pre and post values of AB-ROM in group A was -16.5.

Before the intervention of the mean value of AB-ROM in patients of group B (CTG Group) was 52.9±15.3 and after 2 weeks of intervention mean value of AB-ROM was 67.1±18.2.

The difference between the pre and post values of AB-ROM in group A was -14.2. Students unpaired t test used between group A and group B after 2 weeks revealed that was statistically significant difference between two groups.

Subluxation

The pre intervention mean value of Subluxation in patients of group A (LTG Group) was 2.35±0.81 and after 2 weeks mean value of Subluxation was1.1±0.45. The differences between the pre and post values of Subluxation in group A was 1.25.

Before the intervention of the mean value of Subluxation in patients of group B (CTG Group) was 2.7±0.94 and after 2 weeks of intervention mean value of Subluxation was 1.82±0.87.

The difference between the pre and post values of Subluxation in group A was 0.88. Students unpaired t test used between group A and group B after 2 weeks revealed that was statistically significant difference between two groups.

The incidence of shoulder pain is reported to be approximately after stroke. It can inhibit the muscle contraction and limit efforts of patients to conduct exercise and delay the recovery in the motor function and influence capacity of performing daily activities and social participation, but the mechanisms for shoulder pain are not fully understood [45].

Muscle weakness after stroke is believed to be a primary reason for it. As the shoulder muscles cannot contract effectively against gravity and external force during movement, the humeral head cannot be held in a proper position. Soft tissues around the shoulder may be gradually stretched and torn, resulting in shoulder pain. This understanding constitutes a reasonable mechanism to explain why soft tissue injuries are usually observed in patients after stroke. Other factors such as disturbed sensory and cognitive function are also proved to be involved in shoulder pain. Regardless of the limited understanding of the etiology of this, various therapeutic methods have been trialed to examine their effects on shoulder pain. Different methods (slings and strapping) which can provide effective support to the shoulder are usually involved in the therapeutic strategy for it. Electrical therapy and appropriate exercise program are also proved to be necessary for the treatment of it.

The study indicates kinesio-taping is an effective management strategy for shoulder pain in stroke patient. It has been noticed that some other types of taping methods were trialed to examine their effect on shoulder pain. Regardless of the difference in tapes and taping methods, most of these studies focused on the effect of taping on preventing the development of shoulder pain [45]. As far as we know, few studies examined the effectiveness of kinesiology taping in treating shoulder pain in stroke patient. Actually, kinesiology taping has been widely used to treat musculoskeletal problems. Its effects on nonspecific pain, such as neck pain, impinged shoulder pain, and knee pain, have also been examined.

In the present study, a significant reduction of pain was observed immediately after taping was applied on the first day. In previous studies modulating of pain with immediate effectiveness of kinesio taping was reported on treating impinged shoulder pain, neck pain, and low back pain. However, the mechanism for the immediate effect is still unknown. One of the proposed mechanisms suggests increasing the afferent feedback to the spine. Under the gate control theory, then increase in afferent stimulus can reduce the conducting of nociception into the central nervous system. In addition, the effect of alignment correction may be another potential mechanism. The alignment correction effect on skin and shoulder posture has been proven. The present study also showed notable effectiveness in reducing the shoulder subluxation. It is reasonable that the reduced subluxation can decrease the stimulation to nociception sensors, resulting in pain modulation. Different from the immediate effect on pain modulation, the reduced pain observed after 2 weeks could be ascribed to healing because when the assessment at week 2 post treatment was done without taping [46].

Reducing the subluxation can provide an opportunity to injured tissue to heal. The effectiveness observed after 2 weeks can be ascribed to the enhanced healing process. Based on the finding, it can be concluded that kinesiology taping can provide mechanical support and enhance the healing of injured tissue around the shoulder and act as a sling.

In addition, the muscle activation effect of kinesiology taping has been discussed and studied. Macgregor *et al.* designed a study to investigate the effect of taping on muscle activity in people with patellofemoral pain. Results demonstrated that stretching to the skin via taping can increase muscle activity. Some other recent studies also provided evidence suggesting that taping can affect the muscle activity [50].

However, the muscle activation effect of taping was not supported by the study conducted by Ryan and Rowe in which the symptomatic participants did not show significant changes in surface electromyography indices after taping. In the present study, facilitation technique has been applied to the middle part of deltoid, supraspinatus, and teres minor [47].

Data showed significant improvement in flexion and extension range of in both the groups after taping, implying that kinesiology taping can activate the muscles. However, the increased ROM may also be contributed to the reduced inhibition of pain to muscles and alternated kinesiology induced by increased subluxation. The muscle activation effect might therefore be a result of multiple mechanisms.

It is known that pain is an inhibiting factor to the neuromuscular activity and the effort of a patient to move. The results might indicate that muscle weakness was a dominant reason for the limited AROM. After 2 weeks of treatment, the CTG group showed much greater improvement in FROM and AB-ROM than the LTG group, indicating that CTG taping can enhance the recovery of motor function then LTG taping technique. The effectiveness might be contributed to the reduction of pain which can enhance the initiative of patient to conduct exercise. Furthermore, kinesiology taping longitudinal taping and California Tri taping both seems to be able to activate the neuromuscular function, which is very crucial for the recovery of the motor function in patients after stroke but California tri taping technique is more effective compare to longitudinal Taping technique.

The effects of longitudinal taping and California tri pull taping technique are controversial because some study are supporting and some are not supporting. In acute stroke the main problem of neurological control because the problem in neural drive, therefore the changes in muscle tone create abnormal kinetics of the scapular and rotator cuff group of muscle and it can produce subluxation.

Both taping techniques (longitudinal and California tri pull taping) provides support to the joint and maintain antigravity tension. Its helps to improve scapular and shoulder joint kinetics, improve the sensitivity of joint mechanoreceptors and to improve the muscle tone, pain sensitivity, ROM and neurological control and reduce in subluxation. But in our study the significant improvement in Group B (California tri pull taping group) so we believe that the California tri pull taping is more effective because it may provide the more mechanical support to the joint and able to maintain the antigravity tension properly with improvement in muscle tone, muscle strength and neuromuscular control. Comley-White *et al.* done RCT study in 2018 on effects of shoulder strapping in patients with stroke: and compare the effect of two shoulder strapping techniques in patients with stroke. A longitudinal randomized controlled trial included baseline, weeks one, two and six assessments of 56 participants with upper limb hemiplegia. The participants were assessed for shoulder subluxation, shoulder pain, upper limb motor function and muscle tone. They were randomized into control, longitudinal strapping or circumferential strapping groups. They were concluded trends in improvement showed that longitudinal strapping could be recommended because it positively influenced shoulder subluxation and pain. Even without significant changes, strapping creates awareness of the limb in patients and caregivers and could be of clinical benefit [48]. Yen-Chang HUANG, *et al.*, conducted the placebo-controlled clinical trial to investigate the effects of Kinesio taping for stroke patients with hemiplegic shoulder pain. Twenty-one stroke patients with hemiplegic shoulder pain within 6 months of stroke onset in the rehabilitation ward of a medical university hospital in Taiwan. A 3-week intervention involving a conventional rehabilitation protocol and therapeutic Kinesio taping was conducted with an experimental group of 11 stroke patients. A control group of 10 stroke patients underwent an identical conventional rehabilitation programme and sham Kinesio taping on the hemiplegic shoulder. Numerical rating scale scores, Shoulder Pain and Disability Index, ultrasound findings and pain-free passive range of motion of the affected shoulder, were evaluated before and after the intervention [49]. Lin Yang, *et al.*. done RCT study on effect of kinesiology taping on the hemiplegic shoulder pain aimed to explore the effect of kinesiology taping on hemiplegic shoulder pain (HSP) in terms of pain intensity, magnitude of subluxation, muscle activity, and active range of motion (AROM). Nineteen individuals suffering from HSP were recruited in this study. Patients were randomly assigned into the taping group or control group. The taping group received therapeutic kinesiology taping and conventional treatment, while the control group received placebo taping (applied without tension) and conventional treatment. The shoulder pain intensity (numerical pain rating scale), magnitude of subluxation, muscle activity (measured by surface electromyography (sEMG)), and shoulder active range of movement (AROM) were assessed at the baseline, on the first day (immediately after taping) and 4 weeks after treatment (without taping). They concluded that the kinesiology taping is effective in reducing the shoulder pain and subluxation and increasing muscle activity and AROM for patients with HSP after stroke [45].

Clinical Implication for practice

In the present study 2 weeks of longitudinal taping technique and California tri pull taping techniques with conventional physiotherapy resulted in significant changes in NPRS, F-ROM, AB-ROM and subluxation. Effect of longitudinal and California tri pull taping techniques on subluxation after acute stroke patients proved efficient to decrease pain, improve in flexion and abduction range of motion of the shoulder joint and to reduce subluxation on acute stroke patients. Hence, this technique should be used regularly in neuro-rehabilitation clinic or hospitals to manage pain, ROM and shoulder subluxation after acute stroke.

Limitation of Study

1. At times, it was difficult to convince the patient to use taping technique.
2. At times, patient felt discomfort with taping.
3. The study focused only on acute phase of stroke.

Suggestion for future research

Future research should be done with longitudinal and California tri taping technique on subluxation after acute stroke patients on larger sample size and on more diverse age groups.

Conclusion

The present study concludes that, longitudinal taping and California tri pull taping technique on subluxation after acute stroke patients is effective but California tri pull taping showed to be more effective in improving pain, F-ROM, AB-ROM and to improve in subluxation. Hence, it rejects Null hypothesis and accepts the alternate hypothesis.

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