Effectiveness of the California Tri-Pull Taping Method for Shoulder Subluxation Poststroke: A Single-Subject ABA Design

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KEY WORDS
- bandages
- shoulder dislocation
- shoulder joint
- stroke
- treatment outcome

OBJECTIVE. I evaluated the effectiveness of the California Tri-Pull Taping method for clients with post-stroke inferior shoulder subluxation of the glenohumeral joint.

METHOD. Ten participants were followed for 9 wk using an interrupted time series quasi-experimental single-subject ABA design to examine shoulder pain, activities of daily living (ADL) function, active range of motion, tape comfort, and subluxation.

RESULTS. The California Tri-Pull Taping method decreased inferior subluxation significantly from baseline to intervention but not at postintervention. Active range of motion was significantly increased in shoulder flexion and abduction between the baseline and intervention and the intervention and postintervention phases. Functional ADL scores were significant. The taping was reported to be comfortable. No significant difference in pain was found.

CONCLUSION. This intervention is a promising adjunct to the management of the hemiplegic subluxed shoulder that warrants further research.

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Between 46% and 66% of patients with hemiplegia after a stroke have an inferior subluxation of the glenohumeral joint, in which the head of the humerus is lowered relative to the glenoid fossa of the scapula (Najenson & Pikielny, 1965; Smith, Cruikshank, Dunbar, & Akhtar, 1982; Van Langenberghe & Hogan, 1988). Pain is associated with subluxation and may occur for a variety of reasons. Pain may impede rehabilitation and is associated with longer hospital stays and poorer outcomes (Turner-Stokes & Jackson, 2002) as well as reduced arm function (Lindgren, Jönsson, Norrving, & Lindgren, 2007) and performance of activities of daily living (ADLs; Lee et al., 2009; Lindgren et al., 2007).

The causes of inferior subluxation after stroke are unclear, although many factors have been proposed as contributory (Andersen, 1985; Basmajian & Bazant, 1959; Ikai, Tei, Yoshida, Miyano, & Yonemoto, 1998; Moskowitz, Goodman, Smith, Balthazar, & Mellins, 1969; Runyan, 1995). In approximately 90% of patients early poststroke, the affected extremity is initially flaccid (Moskowitz et al., 1969). The flaccid paralysis of the shoulder muscles compromises the stability of the muscular support of the shoulder because of the abnormal muscle activity of the supraspinatus (Basmajian & Bazant, 1959; Chaco & Wolf, 1971; Ikai et al., 1998) and, in part, the coracohumeral ligament (Basmajian & Bazant, 1959), as well as the posterior fibers of the deltoid (Basmajian & Bazant, 1959; Ikai et al., 1998). Basmajian and Bazant (1959) found that the tightening of the superior part of the capsule plays a role in preventing subluxation. When the arm is even slightly abducted, the tautness of the superior portion of the joint capsule is compromised by becoming slack and requires muscle activity in the rotator cuff muscles.

This muscle activity may be absent when flaccidity occurs after a stroke (Andersen, 1985). Chaco and Wolf (1971) found that subluxation developed within several weeks after a stroke when the arm was flaccid and that normal muscle contraction did not occur in response to loading. The effect of gravity, or *loading,* on the flaccid arm can cause distention to the glenohumeral joint capsule and stretching of the muscle, leading to subluxation (Chaco & Wolf, 1971; Moskowitz et al., 1969). Moreover, if increased downward scapular rotation is present, the slope of the glenoid fossa becomes less oblique, allowing the head of the humerus to slide down into inferior subluxation (Basmajian & Bazant, 1959; Ikai et al., 1998; Runyan, 1995). Downward scapular rotation has, however, not uniformly been found to be prevalent or even contributory to subluxation (Cailliet, 1981; Ikai et al., 1992).

Although subluxation is regarded by many authorities as a major cause of shoulder pain (Andersen, 1985; Griffin & Reddin, 1981; Van Ouwenaller, Laplace, & Chantraine, 1986), several studies have found no direct correlation between subluxation and shoulder pain (Bohannon & Andrews, 1990; Ikai et al., 1998; Van Langenberghe & Hogan, 1988; Zorowitz, Hughes, Idank, Ikai, & Johnston, 1996). Roy (1988) reviewed the literature on the occurrence of shoulder pain in patients with hemiplegia (not specifically subluxed) and found that reported incidence of pain varied between 5% and 84% of patients in different studies as a result of different definitions of pain and patient selection. Roy described Van Ouwenaller et al.'s (1986) report as the most reliable estimate of shoulder pain, with as much as 72% of the population with hemiplegia reporting pain. Other potential causes of shoulder pain are spasticity (Van Ouwenaller et al., 1986); limited shoulder range of motion (ROM), especially in the degree of shoulder external rotation (Ikai et al., 1998; Zorowitz et al., 1996); brachial plexus injuries, especially axillary nerve compression (Shai, Ring, Costeff, & Solzi, 1984) from overstretching of the periarticular tissue (Van Langenberghe & Hogan, 1988) and other impingement syndromes (Ridgway & Byrne, 1999); adhesive capsulitus (frozen shoulder; Ikai et al., 1998; Ridgway & Byrne, 1999); tendonitis (Ridgway & Byrne, 1999), possibly from rotator cuff injuries and tears (Dromerick, Edwards, & Kumar, 2008) or in the long head of the biceps (Dromerick et al., 2008); complex regional pain syndrome (Griffin & Reddin, 1981); and poor position and mishandling (Andersen, 1985; Davis, 2001; Runyan, 1995), especially forcing movement of the arm past 90° of shoulder flexion or abduction before placing the head of the humerus into place or performing ROM on a patient's arm when the scapula is not gliding (Davis, 2001; Griffin & Reddin, 1981). It appears that if a correlation exists between pain and subluxation, it is the result of the increased risk of trauma from improper handling of the subluxed hemiplegic shoulder and overstretching of tissue, possibly leading to impingement problems and tears.

Davis (1985) stated that the problem is not subluxation itself but the complications that may develop from mishandling the arm during transfers, ROM, or other activities. When a therapist is working with a patient exhibiting subluxation and focusing on functional use of the arm, maintaining ROM, and improving independence in ADLs, the best treatment incorporates the subluxed arm while considering the closest approximation of normal movement and scapulohumeral rhythm (Gilmore, Spaulding, & Vandervoort, 2004). This approximation is assumed to be facilitated with the humeral head correctly aligned in the glenoid fossa and full scapular ROM. In addition, pain, which frequently cooccurs with subluxation, needs to be addressed because it can limit a patient's desire and ability to participate during treatment. Currently, no treatment of the subluxed shoulder is completely effective.

Slings and supports have traditionally been used to hold the humeral head in the glenoid fossa. Currently available slings and supports have been found to have varying effectiveness in reducing subluxation (Kieran, Willingham, Schwartz, & Firooznia, 1984; Moodie, Brisbin, & Morgan, 1986; Zorowitz, Idank, Ikai, Hughes, & Johnston, 1995). Some of the different slings and supports on the market support the forearm, support under the axilla, cuff the proximal humerus to reduce downward pull, and apply elastic straps on the anterior and posterior of the arm to the palm to also reduce downward traction. Ridgway and Byrne (1999) examined the pros and cons of slings and reported the benefits of slings as (1) controlling pain, especially tendonitis; (2) reducing self-injury from movement in the context of perceptual neglect or inattention; and (3) supporting a heavy, flaccid upper extremity, thereby reducing stretch to the tissue for a patient who ambulates frequently.

Others (Cailliet, 1981; Hurd, Farrell, & Waylonis, 1974) have questioned the value of slings in addressing pain, subluxation, and ROM, and Miller (1975) has also suggested that slings may have an adverse effect on gait pattern. No sling realigns scapular symmetry or supports the scapula on the ribcage (Cailliet, 1980; Paci, Nannetti, & Rinaldi, 2005); this realignment or support would prevent the downward slope of the glenoid fossa or compensate for reduced activity in the rotator cuff muscles and the superior capsule (Cailliet, 1980). In addition, slings prevent the functional use of the arm and may potentiate spasticity and contractures into a flexed, adducted, and internally rotated position (Moodie et al., 1986; Ridgway & Byrne, 1999; Van Dyck, 1999).

An important finding was that of Morin and Bravo (1997), who determined that strapping the hemiplegic shoulder (wrapping three adhesive elastic bandages from the forearm to the shoulder) in conjunction with a conventional sling for 5 days was more effective in reducing subluxation than when either approach was used individually. Despite its apparent effectiveness, this method limits any use of the strapped arm during a time in which active movement should be encouraged. Alternative methods of treating subluxation have been to position and support the arm by using a table, lab board, or a trough, which can prevent stretching the joint capsule and ligaments but will not approximate the head of the humerus into the glenoid fossa.

Others (Ikai et al., 1992; Wang, Chan, & Tsai, 2000) have found that functional electrical stimulation applied to the supraspinatus and posterior deltoid muscle for as much as a 6-hr period, 7 days/wk for 6 wk, is effective in improving arm function and reducing subluxation. Kobayashi, Onishi, Ihashi, Yagi, and Handa (1999) found electrical stimulation to be effective in reducing subluxation when applied to the supraspinatus and the middle deltoid for 15 min twice a day for 6 wk. However, a meta-analysis by Ada and Foongchomcheay (2002) concluded that although evidence supports the use of electrical stimulation to prevent subluxation early after a stroke, little evidence supports using electrical stimulation late after a stroke.

Different shoulder-taping methods have been discussed in the literature (Ancliffe, 1992; Hanger et al., 2000; Morin & Bravo, 1997; Morin, Tiberio, & Austin, 1997; Peters & Lee, 2003; Peterson, 2004; Shamus & Shamus, 1997; Van Peppen et al., 2004), primarily for shoulder region stability and protection. Researchers have used the term *shoulder taping* interchangeably with *shoulder strapping* (Ancliffe, 1992; Hanger et al., 2000; Morin et al., 1997; Peters & Lee, 2003; Peterson, 2004; Van Peppen et al., 2004). Although the taping application method, as well as the tape's elasticity or rigidity, differs, the similarity is in the use of adhesive tape. The research on the effectiveness of shoulder taping is limited in the population with cerebrovascular accident (CVA) to evaluation of pain (Ancliffe, 1992; Hanger et al., 2000; Peters & Lee, 2003), ROM (Hanger et al., 2000; Peters & Lee, 2003), ADL function (Hanger et al., 2000; Peters & Lee, 2003), and subluxation (Peters & Lee, 2003). The findings are mixed regarding pain, ROM, and ADLs. The single study (Peters & Lee, 2003) on subluxation among this population was a case study and demonstrated a reduction in subluxation. The tape application in Peters and Lee's (2003) study is the most similar to that in the study presented here, yet all three strips of tape were applied at the deltoid tuberosity, not 1.5 in. below, and ran to the posterior portion of the shoulder with the most anterior piece of tape applied over the acromion process to the neck.

Peterson (2004) evaluated the effectiveness of taping combined with electrical stimulation for reducing subluxation in a patient with spinal cord syndrome and found that the interventions may have assisted in reducing subluxation. Peterson placed two pieces of tape on the shoulder; one piece was placed from the insertion of the deltoid muscle, pulled up, and then ended on the acromion. The second piece went from the anterior deltoid and ended at the posterior border of the acromion. One additional shoulder-taping technique to possibly benefit subluxation was discussed briefly by Ridgway and Byrne (1999), but I have been able to identify only one published research study of shoulder taping in the population with stroke that specifically addressed subluxation. I developed the technique introduced in this article using the California Tri-Pull Taping (CTPT) method.

The purpose of this study was to determine whether the CTPT method reduced inferior subluxation, reduced shoulder pain, and allowed for improved ADL function and whether participants' active ROM (AROM) improved or stayed the same. Additionally, if improvement occurred, was it maintained postintervention?

Method

Research Design

The study reported here is an interrupted time series, quasi-experimental, single-subject ABA design across 10 participants. This method allowed for the evaluation of the intervention using fewer participants than are required for a statistically powerful randomized controlled study. Each participant acted as his or her own control. Baseline (A) was the control period. During this phase, the amount of subluxation, AROM, and ADL function of the affected shoulder was measured over a 5-day period. The intervention period (B) consisted of applying shoulder tape every Monday, Wednesday, and Friday for 3 wk for a total of nine taping sessions. During each session, measurements of pain, subluxation, ADL function, AROM, and comfort level of the applied tape were taken. The withdrawal period or postintervention baseline (A) consisted of establishing the postintervention baseline with data collected 3 times, at Weeks 1, 2, and 5 after intervention, to determine whether any gains from the procedure were maintained. The study was approved by the institutional review board at Samuel Merritt University and followed all protocol and standards set by the board.

Participant Recruitment

The participants were recruited over a 4-yr period by means of referrals from occupational therapists and in response to fliers. The participants were screened over the phone and again at the first meeting to assess whether they met the inclusion criteria of (1) poststroke, (2) a minimum of 5 mm (0.2 in.) shoulder subluxation in the involved upper extremity or palpation of at least one finger's-breadth gap between the inferior aspect of the acromion and the superior aspect of the humeral head in comparison with the contralateral upper extremity, (3) an ability to understand and respond to simple verbal instructions or to attend all sessions with a translator, and (4) age ≥ 18 yr. The exclusion criteria were (1) history of severe trauma or debilitating osteoarthritis of the affected shoulder, (2) history of a postsurgical or orthopedic procedure on the affected shoulder in the past year, (3) evidence of fragile skin and open wounds, and (4) past allergies to or current allergic reaction to taping products. All participants had received some amount of therapy after their CVA and before participating in the study, but no data were collected to specify what type or amount of treatment each received. No participants were receiving concurrent treatment or therapy for their hemiplegic upper extremity during their enrollment in the study.

Potential participants were informed of the California Experiments Research Subject's Bill of Rights, as required by California Health and Safety Code Section 24172. On admission into the study, all participants received both written and verbal information as part of the consent process.

Instruments and Outcome Measures

Participants were evaluated for shoulder subluxation using the finger-width palpation method (Hall, Dudgeon, & Guthrie, 1995). This method of measurement achieved a 92% agreement rate between two examiners on 18 patients and attained an intraclass correlation coefficient (ICC) of .77 ($p < .05$) and .89 ($p < .05$), respectively, for two sets of raters (Boyd & Torrance, 1992). A second measure of subluxation used a measuring tape, measuring in centimeters from the inferior aspect of the acromion to the superior aspect of the humeral head. No psychometric properties have been established with this method.

Pain at rest was measured using a visual analog scale (VAS) measured on a 17-cm horizontal-line continuum ranging from 1, indicating *no pain,* to 10, indicating *extreme pain.* Pain at rest was chosen over pain with movement because of the inconsistency of reported amount of pain with different movement (initiating movement, amount of movement, and force of movement). Reliability of VAS measures for chronic pain varies, possibly because of the population evaluated, the range of responses available to the patient, or the option of defined points on the VAS. Crossley, Bennell, Cowan, and Green (2004) found the VAS to be reliable and valid for acute patellofemoral pain, yet no psychometric properties have been established for use with shoulder pain.

AROM was assessed using goniometric measurement for shoulder flexion and shoulder abduction. Intratester and intertester reliability of shoulder movements using a goniometer has been shown to be excellent, with intratester ICCs of .88–.93 and intertester ICCs of .85 and .80 (MacDermid, Chesworth, Patterson, & Roth, 1999).

Functional ADL performance was assessed using the Katz Index of Independence in Activities of Daily Living (Katz, Downs, Cash, & Grotz, 1970). The Katz Index ranks performance in six ADLs (i.e., bathing, dressing, toileting, transfers, continence, feeding). A score of 0 is given for full assistance, 1 for some assistance, and 2 for no assistance. Twelve is the maximum score for full independence in all domains. The Katz Index has been modified over the years and allows for scoring on a 2-point scale or a 3-point scale, as noted earlier. Brorsson and Asberg (1984) found the Katz Index to be reliable and valid. During the intervention phase only, comfort of the tape was measured using a 5-point VAS along a 6-cm horizontal line marked with five equal short vertical lines. Vertical lines 1, 3, and 5 were labeled *uncomfortable, comfortable,* and *very comfortable,* respectively. No psychometric properties have been established for this method of measuring tape comfort.

Intervention

The interveners were the lead researcher (Kate Hayner), who developed the taping method, and graduate students trained by the lead researcher in the taping method and data collection. After training in the CTPT method, students were required to demonstrate proficiency twice before applying the CTPT to participants. Intervention fidelity was established by having the lead researcher present for all participant measurements and interventions.

Before the first intervention day, participants with hair on their shoulder or upper arm were asked to shave the area. Two types of tape were used, a self-adhesive 1.5-in. cotton undercover tape (Mefix; Mölnlycke Health Care, USA, Norcross, GA) and a 1-in. rigid strapping tape (Leukotape P, BSN Medical, Charlotte, NC; supplied by North Coast Medical, Gilroy, CA, for this study). Skin was rubbed with skin prep (a protective skin barrier wipe) before applying the tape for better adherence, and if necessary, a tape remover wipe was used before the skin prep to remove prior tape residue.

Participants placed their affected arm on a supporting surface to better approximate the humeral head back into the glenoid fossa. The three pieces of rigid tape were applied to the patient's shoulder on top of the already applied self-adhesive cotton tape. The first piece (medial) was applied from 1.5 in. below the deltoid tuberosity running straight up the middle of the arm to 2 in. above the top of the glenoid fossa between the clavicle and the spine of the scapula. The second piece (posterior) was located from 1.5 in. below the deltoid tuberosity to 1.5 in. above the middle of the spine of the scapula. The medial border of this second piece ran along the acromial process. Last, the third piece (anterior) was located from 1.5 in. below the deltoid tuberosity to run around the front of the humeral head and over the coracoid process, up to 1.5 in. above the clavicle (Figure 1). The tape was removed and new tape applied every Monday, Wednesday, and Friday and remained on the patient for 3 consecutive weeks.

Data Collection

Data were collected by both graduate students and the lead researcher. None of the data collectors were blind to the study's purpose. Baseline measurements were taken twice during the 1st week, 5 days apart. Intervention data were collected on 9 days over 3 wk (Monday, Wednesday, and Friday), and the postintervention baseline data were collected 3 times, once a week for 2 wk, followed by a third measurement visit 3 wk later. During all three phases, the following data were collected: subluxation, pain (during intervention, this measurement was taken before the tape was applied), and AROM for shoulder flexion and abduction. During the baseline and postintervention phases, an additional measurement of functional ADL performance was taken.

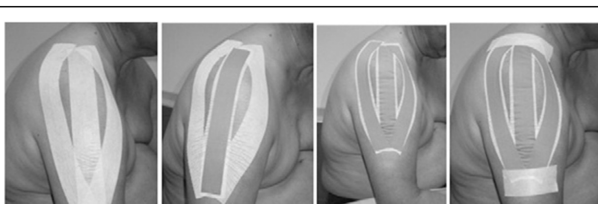

Figure 1. Sequence of taping.

Data Analysis

Two data analysis methods were used. In the first method, dependent variables for each participant were plotted on a graph to show trend lines. In the second method, the Wilcoxon matched-pairs signed-ranks test (Flores, 1989) was used to check for differences in the mean score and ratings of participants during the different phases of the study.

Because of differences in the frequency of data collected at each stage of the study (baseline, intervention, postintervention baseline), the average rating for each participant was used during each stage for all five dependent measures (shoulder pain, ADL function, AROM, tape comfort, amount of subluxation). The Wilcoxon matched-pairs signed-ranks test was used to check for significant differences between each phase, using the average values of each individual at each stage from all participants. Differences among the participants at each stage were not examined.

Results

Participant Demographics

Ten participants were enrolled in the study, 7 men and 3 women. Each participant had a diagnosis of stroke and presented with an inferior subluxation of the shoulder as per the inclusion criteria. Time since stroke varied widely; 4 participants were 1–6 mo poststroke, 1 participant was 7–12 mo poststroke, 2 participants were between 1 and 2 yr poststroke, and 3 participants were 2–5 yr poststroke. No participant received concurrent treatment of shoulder subluxation or shoulder pain while participating in the study.

Participant 4 reported a fall at home followed by increased measures of pain during the first postintervention baseline measure. At this visit, Participant 4 opted to drop out of the study so that the tape could be reapplied for a reported reduction in his pain. In addition, Participant 1 withdrew from the study at Intervention 8 because of an unrelated medical complaint.

Active Range of Motion

Shoulder flexion. Several participants' goniometric measurement results indicated an increasing trend in active shoulder flexion from the initial baseline stage through the end of the intervention stage and also 3–5 wk after intervention (Figure 2). Two participants (1 and 2) who had no change in AROM exhibited a flaccid extremity at initial baseline with no return of active movement over the duration of the study. No explanation was found for Participant 4's change from the initial slight active shoulder flexion to no active flexion starting on Intervention Day 2. The mean degrees of shoulder flexion across participants during the baseline, intervention, and postintervention baseline stages were 37.15°, 47.43°, and 67.84°, respectively.

Participants' active shoulder flexion significantly improved as a result of the CTPT method through the measurement periods. A statistically significant difference was found in active shoulder flexion from the initial baseline to the intervention phase ($z = -2.257$, $p = .02$). Participants continued to significantly improve their active shoulder flexion during the 3- to 5-wk postintervention baseline ($z = -2.018$, $p = .04$).

Abduction. Plotted trend lines for active shoulder abduction suggest increased abduction at each stage, although data from some participants indicated no change. The overall mean values (in degrees of active abduction) during the baseline stage, intervention, and postintervention phase were 39.55°, 46.76°, and 64.72°, respectively. The p values from the Wilcoxon signed-ranks tests were significant, indicating increased levels of active shoulder abduction in the intervention phase compared with baseline levels ($z = -2.26$, $p = .02$). A significant difference was also found in mean active shoulder abduction from the intervention phase to the postintervention baseline ($z = -2.61$, $p = .01$), indicating that the gains were maintained.

Functional Ability During ADLs

Visually, the increased ADL function on the Katz Index between the baseline and the postintervention phase was evident, with functional increases between the two stages for most participants. The mean functional ADL scores were significantly different between the two stages ($z = -2.56$, $p = .01$). The mean values for the initial baseline and the postintervention baseline were 8.70 and 9.77, respectively.

Pain at Rest: Before Taping

No overall trends were found in the amount of pain experienced by participants during the different stages of the experiment (Figure 3). Many participants fluctuated in their self-reported pain levels, but all but one participant who started with any reported pain reported a reduction in pain from initial to postintervention baseline. The p value from the Wilcoxon signed-ranks tests comparing differences between the initial baseline means and the intervention phase approached significance ($z = 1.86$, $p = .06$). The average pain level reported during each stage of the experiment was 3.45 during the initial baseline, 2.02 during the intervention phase, and 1.32 during the postintervention baseline. No significant difference was found in the amount of pain experienced at rest during intervention and at the postintervention baseline ($z = 1.07$, $p = .29$).

Subluxation

The amount of subluxation was recorded with the tape removed. In general, a decline in the amount of subluxation was evident from the initial baseline values through the end of the intervention phase (Figure 4). However, graphically the trend is not as clear from the date of the last intervention through the 5th wk of postintervention measurements because the participants had varying changes in subluxation.

The reduction in subluxation was statistically significant only from baseline to intervention ($z = 2.40$, $p = .02$).

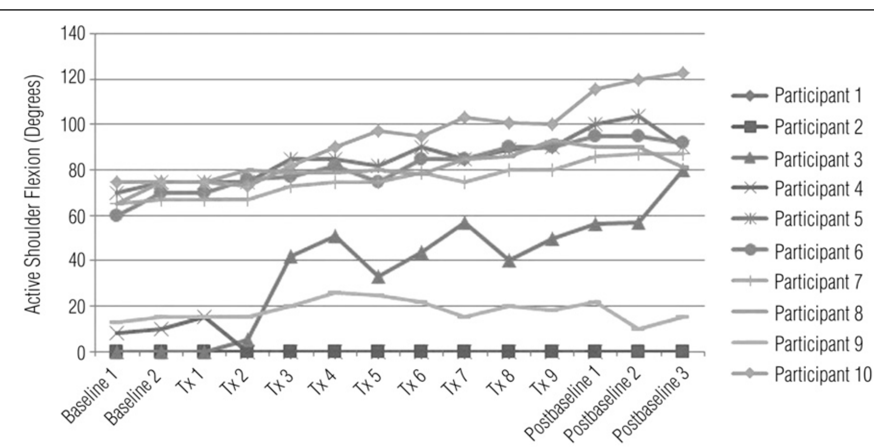

Figure 2. Active shoulder flexion.
Note. Tx = treatment.

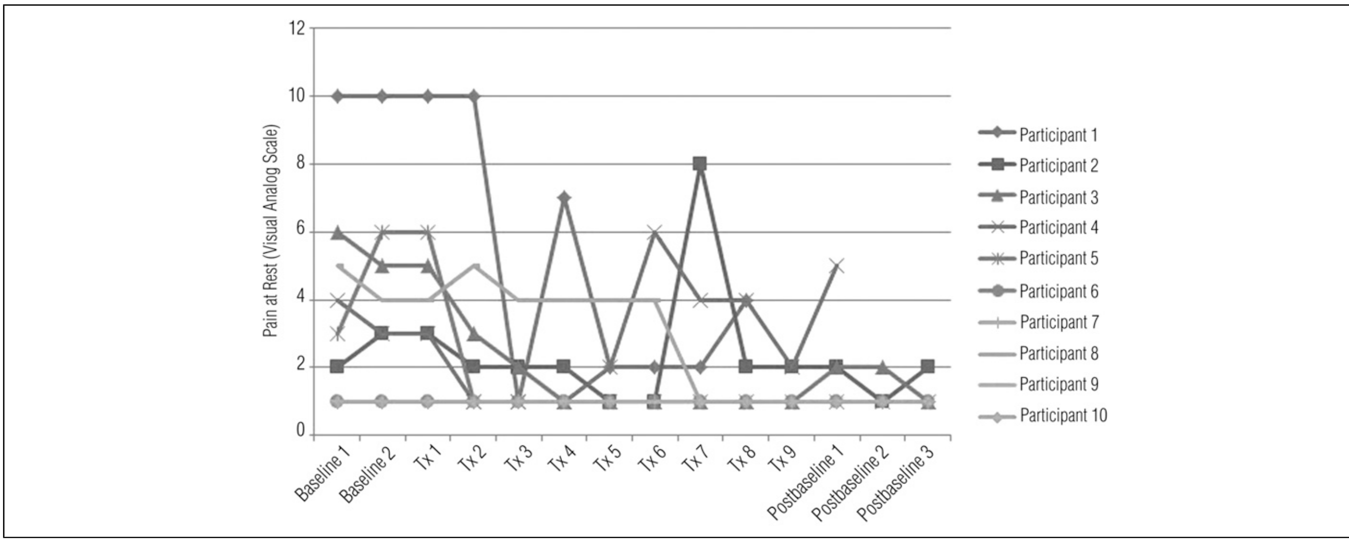

Figure 3. Pain at rest before taping.
Note. Tx = treatment.

The mean intervention and the mean postintervention baseline levels were not significantly different ($z = 1.72$, $p = .09$). The average amount of subluxation during the baseline, intervention, and postintervention stages of the experiment was 1.99 cm, 1.37 cm, and 0.98 cm, respectively.

Comfort of the Tape

All the participants reported that the tape was either comfortable or very comfortable at all nine intervention sessions, with the exception of one report. No statistical analysis was performed because the tape was consistently reported as comfortable. The average comfort rating was 4.4 (standard deviation = 0.59). The participants ranked their comfort similarly.

Discussion

This study indicated that the CTPT method benefited clients with inferior subluxation poststroke in subluxation, AROM, and ADL function. Additionally, all the participants reported the CTPT method to be consistently comfortable to very comfortable.

Changes in patients' report of pain, although not statistically significant, warrant detailed consideration. The greatest variation in pain was reported by Participant 1, who reported a level of pain "beyond 10" at baseline and a level of 4 on her last visit, at Intervention Day 8 (she withdrew from the study because of an unrelated medical complaint). Three participants showed several spikes in reported pain because of unrelated events. Participant 1 had a spike from Level 1, *no pain,* to

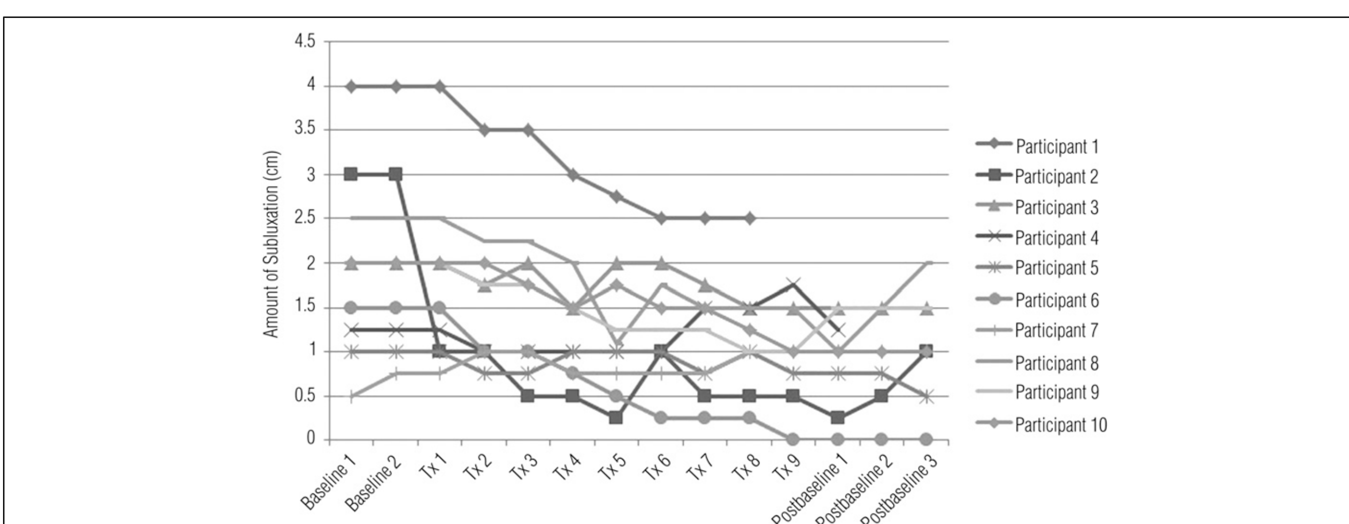

Figure 4. Subluxation before tape was applied.
Note. Tx = treatment.

Level 7 and then down to Level 2. No explanation for this spike was given. Participant 2 had a spike between Intervention Day 6, when no pain was reported, and Intervention Day 7, when pain was reported as Level 8, and pain then returned to Level 2 at Intervention Day 8. This participant reported that his arm had moved into abduction and dislocated during his sleep. Participant 4 reported on Intervention Day 6 that movement of his arm (by another person) had caused discomfort in his shoulder; he went from Level 2 pain to Level 6 and then back down slightly. In addition, Participant 4 had a spike of 3 points (from 2 to 5) on the first postintervention baseline measure resulting from a reported fall at home with increased pain. At this visit, Participant 4 opted to drop out of the study so that the tape could be reapplied.

Because no other interventions were administered, the amount of improvement in AROM and function was unexpected. The improvement in AROM may be in part the result of a reduction in pain (for those participants with a reduction) and in part the result of a reduction in subluxation. These reductions would in turn allow for more normal movement patterns. If, as some researchers have suggested (Najenson & Pikielny, 1965; Paci et al., 2005; Shahani, Kelly, & Glasse, 1981), inferior subluxation is partially the result of overstretching the joint capsule—the muscle and ligaments around the shoulder joint—because of loading (Chaco & Wolf, 1971), the CTPT method may have reduced the pull on the overstretched tissue by replacing the required action of the supraspinatus muscle (Chaco & Wolf, 1971) and allowing the soft tissue to shorten, thereby reducing the inferior subluxation.

Additionally, other benefits to this method of treating subluxation is that it allows for some protection from further trauma to the unsupported subluxed arm during ambulation and ADL activities by approximating the head of the humerus into the glenoid fossa by assisting the rotator cuff muscles. The CTPT is also easy to apply and allows for functional movements, thus allowing for early engagement in activities.

This preliminary report on the CTPT method is promising, but more research is required to further assess the benefits found in this study.

Limitations

Limitations of this study are the small sample size, that interveners were not blinded to the study's purpose, and that the data were collected by the lead researcher, who was the originator of the method. To increase confidence in the results (Kazdin, 1982), this research was conducted with participants whose length of time since stroke varied, which increased the diversity of the population. Although palpation has been highly correlated with precise radiologic measurements (Hall et al., 1995; Prévost, Arsenault, Dutil, & Drouin, 1987) for determining the presence and extent of subluxation, the method of measurement in this study, using palpation and a tape measure, may not have given measurements as exact as radiologic results. Further studies looking at the effectiveness of the CTPT method may obtain more precise data using radiographic measurements, which could provide further evidence of how much reduction in subluxation was obtained by each participant. Despite the small sample size, the effects were sufficient to suggest this study should be evaluated by independent researchers with a larger study sample.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- The CTPT method offers an intervention for addressing subluxation that is quick and easy to apply and is reported to be comfortable.
- This taping intervention, when applied, allows for functional use of the subluxed extremity.
- This study's findings indicate that this method reduces subluxation during the taping period.
- Improvements in active shoulder flexion and abduction were significant. This improvement would allow for increased functional ability for clients with nonflaccid extremities.
- The significant improvements found in functional ADLs after the taping would benefit any client working on increased independence. ▲

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