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Comparison of the Effectiveness of Two Different Types of Slings in Shoulder Subluxation After Stroke

İnme Sonrası Omuz Subluksasyonunda İki Farklı Askı Tipinin Etkinliğinin Karşılaştırılması

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ABSTRACT Objective: The purpose of this study is to investigate the effectiveness of shoulder slings on pain, motor function, daily life and balance in acute hemiplegic patients with shoulder subluxation and to investigate whether different types of slings are superior to each other. **Material and Methods:**Thirty-two patients with hemiplegic shoulder subluxation due to acute stroke were divided into 2 groups: shoulder supported slings (Group1, n=20) and forearm supported slings (Group2, n=20). **Results:** At the end of treatment, no significant decrease was achieved in the severity of shoulder pain in 2 groups. There was a statistical increase in BI scores and Berg Balance scores in both groups, while there was no difference between the 2 groups. There was a statistically significant increase in the Fugl Meyer score in Group 1 following treatment (3.0±3.1; p=0.007), while there was none in Group 2 (2.2±5.9; p=0.063). In the comparison of the groups, Fugl Meyer scores were significantly higher in Group 1 compared to Group 2 (p=0.048). **Conclusion:** It was determined that after the development of shoulder subluxation in patients with acute stroke, slings with shoulder or forearm support positively affect the balance and daily life activities of patients, and in addition, slings with shoulder were more effective in improving motor functions.

Keywords: Stroke; subluxation; shoulder; slings

ÖZET Amaç: Bu çalışmanın amacı, akut dönem hemiplejik hastalarda omuz subluksasyonunda omuz askısının ağrı, motor fonksiyon, günlük yaşam ve denge üzerindeki etkinliğinin ve farklı tipte kullanılan askıların birbirine üstünlüğünün olup olmamasının araştırılmasıdır. **Gereç ve Yöntemler:** Akut inmeye bağlı hemiplejik omuz subluksasyonu olan 32 hasta, omuz destekli askı (Grup 1, n=20) ve önkol destekli askı (Grup 2, n=20) kullanılan 2 gruba ayrıldı. Tüm hastalara, hemipleji rehabilitasyonu pasif ve aktif-yardımlı eklem hareket açıklığı, germe ve nörofizyolojik egzersizler 8 hafta boyunca her gün yapıldı. Ağrı değerlendirmesi Vizüel Analog Skala ile sensorimotor değerlendirme Fugl Meyer değerlendirmesiyle, günlük yaşam aktivitesi Barthel İndeksi ve denge Berg Balance Skalası ile değerlendirildi. **Bulgular:** Omuz ağrı şiddetinde, 8 haftalık tedavi sonunda hem Grup 1 hem de Grup 2'de anlamlı azalma elde edilememiştir. Barthel İndeksi skorlarında ve Berg Balance Skalası skorlarında her iki grupta da istatistiksel bir artış var iken, 2 grup arasında fark yoktu. Fugl Meyer skorunda, tedavi sonrası Grup 1'de (3,0±3,1; p=0,007) istatistiksel olarak anlamlı bir artma meydana gelirken, Grup 2'de (2,2±5,9; p=0,063) yoktu. Gruplar karşılaştırıldığında, Grup 1'de Grup 2'ye göre Fugl Meyer skorları anlamlı olarak daha fazlaydı (p=0,048). **Sonuç:** Akut inmeli hastalarda, omuz subluksasyonu gelişiminden sonra omuz veya önkol destekli askıların denge ve günlük yaşam aktivitelerini olumlu etkilediği ve ek olarak; omuz destekli askı kullanımının motor fonksiyonları geliştirmede daha etkin olduğu gözlemlendi.

Anahtar Kelimeler: İnme; subluksasyon; omuz; askı

Stroke is the most common neurological disease in the world and is one of the most important causes of death and chronic loss of functional abilities.[1] Problems with the upper extremities in hemiplegic patients negatively affect rehabilitation and prognosis. Primary upper extremity complications in stroke

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are glenohumeral subluxation, compression syndrome, frozen shoulder, central pain, complex regional pain syndrome, brachial plexus injury, heterotopic ossification, and loss of movement in the joints of the shoulder, elbow, fingers due to spasticity and contracture. Glenohumeral subluxation is the most common complication in hemiplegic patients and occurs in 5-84% of patients.[2] Due to loss of muscle stability in the flask period, the scapula is rotated down, and the glenoid fossa passes from the oblique direction to the vertical direction, causing the lower subluxation of the humerus. Strong downward pulling of latissimus dorsi and rhomboid muscles in the spastic period leads to down-rotation and depression of the scapula. This, in turn, may change the slope of the glenoid fossa, leading to subluxation. Inferior subluxation is most common in hemiplegic patients. As a result of the disappearance of inferior support at the humeral head in inferior subluxation, the humerus shifts from the labrum of the glenoid fossa.[2-4] Clinical and radiological methods are used in the diagnosis of glenohumeral subluxation. From a clinical perspective, the gap between the humeral head and the acromion is more pronounced than that of the solid side by palpation. Radiologically, graphs are performed and evaluated in an oblique position of 45° with the arm unsupported.

Positioning in flask period is important in order to prevent the development of glenohumeral subluxation. Shoulder should be positioned in abduction, external rotation, and elevation. The purpose of sling use is to support the weight of the upper limb, reposition the humeral head and prevent sudden uncontrolled movements of the paretic arm. However, sling use in shoulder subluxation after a stroke is controversial. There is no consensus on which sling is better with respect to shoulder subluxation based on conducted studies.[5] In a study by Brooke et al. in which different slings were compared, it was determined that forearm supported slings (Harris sling) forearm provided the best vertical correction in radiographic imaging techniques. It was shown that shoulder supported slings (Bobath sling) was less effective in distraction of the horizontal of the humeral joint.[6] Williams et al. compared the efficacy of Bobath axillary sling and Henderson shoulder loop, which are 2 types of shoulder slings used in the treatment of shoulder subluxation in hemiparetic patients, and determined that there was no difference between the 2 orthoses in reducing the inferior subluxation of the shoulder.[7]

In our study, we used 2 different types of sling with shoulder and forearm support for shoulder subluxation in stroke patients. The purpose of this study is to investigate the effectiveness of shoulder sling on pain, motor function, daily life and balance in acute hemiplegic patients and to investigate whether different types of sling used are superior to each other.

MATERIAL AND METHOD

Eighty five patients between the age of 20 and 75 with hemiplegic shoulder subluxation were evaluated for the study, and 40 patients were included in the study. Thirty two patients completed the study. The study was designed as a prospective, randomized and controlled study. Shoulder subluxation was diagnosed by palpation, then evaluated by radiographic measurements in the sitting position with the plane of the scapula method (coronal plane up to 30 degrees).

During hospitalization, 2 different types of sling with shoulder or forearm support were used in addition to conservative treatment. The slings were put by a trained physiotherapist. Participants wore their devices during the active time of the day for a period of 8 weeks, but removed them at night or during the period of lying on their back. For compliance with therapy, the physiotherapist and family were informed about the procedure, and the patient's compliance was checked. A standard rehabilitation program was carried out for all patients. Hemiplegia rehabilitation passive and active-assistive range of motion, stretching, and neurophysiologic exercises were performed by all patients 60 minutes a day for 8 weeks.

Patients were assigned to 2 groups, shoulder supported slings (Group 1, n=20) and forearm supported slings (Group 2, n=20), by an investigator who was blinded to the study via randomization created by a computer software. Evaluation of the detailed physical examination results, evaluation of demographic features such as age, gender, and etiology as well as evaluation of treatment results were performed by the physiatrist who was blind to randomization.

Patients were given written and oral information about the purpose, duration and methods of application of the study, and after receiving their approval, the "informed subject consent form" was signed. The study was approved by the Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital (date: January 8, 2018, no: 2018-01-18) and has been prepared in accordance with the Declaration of Helsinki principles.

Criteria for inclusion in the study:

- Acute patients who were independent and ambulatory prior to stroke and had their first stroke attack (<3 months),

Mini-Mental Status Test score ≥24,

- Developing hemiplegia after stroke, standing independently for at least 2 minutes,

- Lower limb being in stage 4-5 according to the Brunnstrom approach (for ambulation and standard balance),

- Upper limb being in stage 1-2 according to the Brunnstrom approach,

- Spasticity 0-+according to Modified Ashworth Scale.

Criteria for exclusion from the study:

- Having a neurological history other than the diagnosis of hemiplegia (Parkinson's etc.),

- Having used shoulder slings and orthosis,

- Having a disease that can affect balance (cranial, etc.).

INTERVENTION

Shoulder supported sling is an 8-shaped sling and has an armrest and vertical sling system to support the axillary weight of the affected shoulder. One of the belts that make up the 8 shape circulates around the unaffected shoulder, and the 2 girths merge between the shoulders on the back.[8] This design ensures that the arm is free so that it can be used for everyday activities.

Forearm supported slings consist of a pad covering the elbow, a second pad on the wrist and hand, and adjustable slings extending from these pads to the connecting part on the back. With this sling, the shoulder is held in adduction and internal rotation.[6] The purpose of this type of slings is to indirectly immobilize and support the shoulder by supporting the forearm.

EVALUATION PARAMETERS

Visual Analog Scale

In our study, a 10 cm line called Visual Analog Scale (VAS), a visual method for pain assessment, was used. On this line "0" refers to painlessness, and "10" refers to unbearable pain.[9] Shoulder pain of the patients was evaluated twice at the beginning and end of treatment.

Barthel Index

The Barthel Index (BI) contains 10 items that assess daily life activities and mobility. It evaluates feeding, bathing, dressing, grooming, bowel and bladder continence, getting on and off the toilet, transfers (bed to chair and back), mobility (on level surfaces), ascending and descending stairs. A score is calculated based on whether the person has received help in performing these activities. 0-20 points mean totally dependent, 21-61 points mean severely dependent, 62-90 points mean moderately dependent, 91-99 points mean slightly dependent, and 100 points mean fully independent.[10]

Fugl Meyer Assessment

The Fugl Meyer Assessment (FMA) is the first criterion for quantitatively evaluating sensorimotor recovery after stroke. It is based on the motor recovery stages of Twitchell and Brunnstrom. It consists of 5 parts: motor function (upper and lower extremities), sensory function, balance, joint range of motion and joint pain. The FMA for upper extremity (FMA-UE) section was used in our study. In the evaluation of the arm, reflex activity and synergy-dependent and synergy-independent movements are examined, and the total score is 36. In the evaluation of the wrist, the movements of the wrist in different positions of the shoulder and elbow, and complex movements of the wrist are examined, and the total score is 10. In the hand evaluation, flexion, extension and 5 different types of grip are examined and total score is 14. In the evaluation of coordination and speed, tremor, velocity, and dysmetria are examined and the total score is 6. The highest score for the Fugl Meyer Motor Function Scale-UE is 66. Scores between 0 and 19 indicate severe upper extremity motor dysfunction, scores between 20 and 46 indicate moderate upper extremity motor dysfunction and scores between 47 and 66 indicate mild upper extremity motor dysfunction.[11]

Berg Balance Scale

Berg Balance Scale (BBS) is a scale that contains 14 directives and is scored between 0 and 4 points by observing the patient's performance for each directive. In cases where the patient cannot perform activity at all, 0 point is given, while 4 points are given when the patient independently completes the activity. The highest score is 56. 0-20 points indicate an impairment in balance, 21-40 points indicate the presence of an acceptable balance and 41-56 points indicate the presence of a good balance. It takes between 10 and 20 minutes to complete the scale.[12]

STATISTICAL ANALYSIS

SPSS software (Version 22.0, IBM Corp., Armonk, NY, USA) was used in the analysis. The descriptive statistics of the data were expressed by mean values for continuous variables and standard deviation and counts and percentage for categorical variables. Mann-Whitney U test and chi-squared test were used in the analysis of qualitative independent data. The Shapiro-Wilk test was used to analyze the normal distribution of quantitative variables. Wilcoxon signed-rank test was conducted to assess intra-group changes. In addition, the Mann-Whitney U test was used to compare group differences at each time point. The level of significance was determined as $p<0.05$.

RESULTS

PARTICIPANT CHARACTERISTICS

The demographic and clinical characteristics of the patients are summarized in Table 1. The last sample size consisted of 32 (Group 1, n=15; Group 2, n=17) patients. Eight patients were excluded from the last analysis due to unwillingness to participate. There was no significant difference between the 2 groups in the initial evaluation in terms of demographic and clinical characteristics of the patients and all evaluation criteria ($p>0.05$).

OUTCOMES

At the end of 8-week treatment, no significant decrease was achieved in the severity of shoulder pain in either Group 1 or Group 2 (0.1±1.3; p=0.914, -0.4±2.0; p=0.382, respectively). Furthermore, there was no significant difference between groups in terms of VAS scores (p=0.124) (Table 2).

TABLE 1: Demographic and clinical features of patients.

Characteristics	Group 1 (n=15) Mean±SD or n (%)	Group 2 (n=17) Mean±SD or n (%)	p values
Age (years)	66.9±11.2	68.0±9.5	0.766
Sex, female/male	7 (46.7)/8 (53.3)	6 (35.3)/11 (64.7)	0.720
Hemiplegic side, right/left	4 (26.7)/11 (73.3)	6 (35.3)/11 (64.7)	0.712
Dominant extremity, right/left	13 (86.7)/2 (13.3)	16 (94.1)/1 (5.9)	0.589
Etiology			
Ischemic	10 (66.7)	14 (82.4)	0.423
Hemorrhagic	5 (33.3)	3 (17.6)	
Brunnstrom (proximal)			
Stage 1	12 (80.0)	10 (58.8)	0.265
Stage 2	3 (20.0)	7 (41.2)	
Mini-Mental Status Test	22.3±3.7	21.6±4.4	0.602

SD: Standard deviation. Means (SD) is given for continuous variables; n (%) is given for categorical data. p values for continuous variables were calculated using Mann-Whitney U test; p values for categorical data were calculated using chi-squared test.

TABLE 2: Within-and between-group changes of outcome measures in both groups.

Outcome measures		Mean±SD Baseline	Within-group 8-week	Between-groups Mean±SD p values	p values
VAS, 0-10	Group 1	3.2±2.6	3.3±2.0	-0.1±1.3; p=0.914	0.124
	Group 2	3.9±2.7	3.4±1.9	0.4±2.0; p=0.382	
Barthel Index, 0-100	Group 1	29.3±15.6	37.3±16.4	-8.0±8.4; p=0.007*	0.984
	Group 2	22.6±21.2	31.5±24.9	-8.8±12.2; p=0.001*	
Fugl-Meyer Assessment, 0-66	Group 1	4.4±6.5	7.4±6.7	-3.0±3.1; p=0.007*	0.048*
	Group 2	8.4±10.3	10.6±10.3	-2.2±5.9; p=0.063	
Berg Balance Scale, 0-56	Group 1	6.9±6.9	12.2±7.3	-5.3±2.6; p=0.001*	0.153
	Group 2	8.9±11.4	14.8±15.1	-5.8±8.7; p=0.001*	

VAS: Visual Analog Scale; SD: Standard deviation. p values for within-group comparisons were calculated using Wilcoxon signed-rank test; p values for between-group comparisons were calculated using Mann-Whitney U test. *p<0.05.

As shown in Table 2, after 8-week treatment, there was a statistical increase in BI scores (p=0.984) in both Group 1 (8.0±8.4; p=0.007) and Group 2 (8.8±12.2; p=0.001) without any significant difference between the 2 groups.

There was a statistically significant increase in the FMA score in Group 1 following treatment (3.0±3.1; p=0.007), while there was none in Group 2 (2.2±5.9; p=0.063). In the comparison of the groups, FMA scores were significantly higher in Group 1 compared to Group 2 (p=0.048) (Table 2).

There was a statistically significant increase in BBS score at the end of treatment in both Group 1 and Group 2 (5.3±2.6; p=0.001, 5.8±8.7; p=0.001, respectively). However, there was no statistically significant difference in the group comparison (p=0.153) (Table 2).

DISCUSSION

According to the results of the study which investigated the effectiveness of 2 different slings used during shoulder subluxation in patients with stroke, while neither sling had a significant effect on reducing shoulder pain, there was a statistically significant increase in daily life and balance. It was determined that only shoulder supported slings had an effect on motor functional development. In the intergroup comparison, shoulder supported slings provided a statistically more significant increase in motor functional development compared to forearm supported slings. There was no difference between the 2 slings in terms of their effectiveness on pain, balance and daily life activity.

Glenohumeral subluxation, a cause of shoulder pain, occurs in patients where joint stabilization is impaired. Normal shoulder joint position is disturbed due to loss of strength, paralysis, loss of tonus and proprioceptive losses in the muscles after a stroke. Abnormal muscle tone in the spasticity period leads to poor scapular position and restricted movement. The risk of complications should be minimized by precautions to be taken at an early stage. Although the relationship between subluxation and hemiplegic shoulder pain remains unclear, shoulder slings are widely used to correct this subluxation.[6,7,13]Positioning is of great importance in the flask period.[14] In a meta-analysis conducted by Ada et al. on the effectiveness of supporting devices in the treatment of hemiplegic shoulder subluxation, no effect on pain was demonstrated which was similar to our study.[15] Similarly, in the recent randomized, controlled study by Van Bladel et al. conducted with patients with hemiplegic shoulder subluxation, patients were divided into 3 groups: those who did not use any sling, those who used slings with shoulder support (Shoulderlift Brace (VIGO, Wetteren, Belgium) and those who used slings with forearm support [Actimove® sling (BSN Medical SA-NV, Leuven, Belgium)]. At the end of sling use for 6 weeks, there was no significant difference between groups in terms of pain change.[16] In addition, a study of Hesse et al. reported that shoulder slings improved the quality of walking, fixed the humeral head better, facilitated performance activities, but did not reduce pain, which was similar to our study.[17] In the studies, absence of pain reduction after sling use, restriction of shoulder joint range of motion, risk that elbow flexor spasticity may increase, and discomfort and unpleasant odor may be the reasons limiting orthosis use. Contrary to this, Hartwig et al. reported that functional shoulder orthosis [Neuro-Lux (Sporlastic GmbH, Nürtingen, Germany)] helped reduce the development of clinical symptoms of shoulder-hand syndrome in subacute stroke patients.[18] We believe that the significant improvement in the aforementioned study depends on the evaluation method used which was different from our study.

In hemiplegic patients, the group which has the biggest risk of falling is the one with dysfunction of the upper extremities.[19] Our study included patients with upper extremity dysfunction in order to determine the effects of the slings on the balance. A study conducted with 31 hemiplegic patients evaluated the patients by walking analysis that have slings with forearm support and those without slings. All patients walked at their own pace, on a 10-meter track with shoulder slings and without slings. At the end of the study, it is shown that the stepping phase was prolonged, walking speed and weight transfer to the paretic side increased, while the deviation in the center of gravity decreased. It is noted that the shoulder sling helped postural adaptation with the feedback mechanism and thus reminded the patient of their arm.[20] Acar et al. conducted a study with 26 hemiplegic patients and evaluated the balance of the patients statically with Kinesthetic Ability Trainer (KAT) 3000 (KAT 3000, Med-Fit Systems Inc., Fallbrook, CA, USA) device and functionally with BBS and functional reach (FR) with and without slings. The average of the measurements made with the KAT device with slings yielded better results compared to the average of the measurements made without slings. The difference was statistically significant. BBS and FR test measurements with slings yielded better results compared measurements without slings, and the difference was statistically significant.[21] Şahin et al. conducted a study with 23 hemiplegic patients and evaluated the balance of the patients using BBS and KAT with and without slings. The positive effect of slings with forearm support on balance was shown in early stages and especially in patients with lower Brunnstrom stage.[22] Our patients' BBS measurements were in the medium-high risk group. In our study, both shoulder slings had positive effects on balance.

Another factor that may be associated with glenohumeral subluxation is the motor function of the upper limb. Functional improvement accompanied by increased muscle strength, ensures a decrease in the risk of subluxation.[23] Functional improvement is also accompanied by the recovery of sensory and proprioceptive stimulation, strengthening the autocontrol mechanisms related to the upper extremity of a person.[24] In our study, the most prominent change in terms of the effectiveness of 2 shoulder slings was in Fugl Meyer scores. While there was a statistically significant change in patients with slings with shoulder support, there was no significant change in those who used slings with forearm support. In the aforementioned study by Van Bladel et al. in patients with hemiplegic shoulder subluxation group, there was a significant increase in Fugl Meyer scores in the group using shoulder supported slings and the control group with no sling use compared to the group using slings with forearm support. In this study, similar to our study, there was an increase in motor functional status when shoulder movements were not restricted.[16]

Our study showed a significant improvement in our patients using both types of sling based on our assessments for daily life activities at the end of 8 weeks of rehabilitation period. We believe that the exercises for the 2 groups and patients being in the recovery process contribute significantly to this. In a study by Ada et al. on 46 patients suffering from acute stroke with the risk of shoulder subluxation, experimental group Lap-tray while sitting and triangular sling while standing and control group using hemi-sling while sitting and standing were compared. As a result, there was no significant difference in subluxation and activity limitation in 2 groups.[25]

Limitations of our study are the small number of patients, lack of long-term follow-up and lack of a control group.

CONCLUSION

In conclusion, based on the data obtained, it was observed that slings with shoulder or forearm support had a positive effect on the balance and daily life activities in patients with acute stroke after the development of shoulder subluxation and in addition, slings with shoulder support were more effective in developing motor functions. According to the literature and results of our study, we believe that slings with shoulder support can be more effective than slings with forearm support. Studies with different types of slings and larger number of patients are needed.

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