Effect of Comprehensive Postural Instructions and Range of Motion Exercises Via Educational Videos on Motor Function and Shoulder Injury in Stroke Patients With Hemiplegia: A Preliminary Study

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Abstract

Objective: The purpose of this study was to investigate the effect of comprehensive postural instructions and range of motion (ROM) exercises via educational videos for shoulder injury prevention and functional improvement of the hemiplegic shoulder after acute stroke.

Methods: In this prospective cohort study, 48 subacute stroke patients with hemiplegia were enrolled and divided into 2 groups (23 in experimental group and 25 in control group). In the control group (n = 25), the patients performed conventional rehabilitation for 5 days per week. In the experimental group (n = 23), the patients received not only conventional rehabilitation but also additional postural instructions and regular ROM exercises via educational videos for hemiplegic shoulders for 15 minutes twice per day for 5 days per week during their hospital stay. Main outcome measures, including the presence and severity of pain, motor function, and sonography on hemiplegic shoulder, were assessed.

Results: More motor recovery improvement was found in the experimental group ($P < .05$). In the supraspinatus tendon, a significantly increased frequency in tendinopathy or tear was observed between admission (12%) and before discharge (40%) in the control group ($P < .05$), but no difference was observed in the experimental group. In the subdeltoid bursa, effusion or bursitis was significantly reduced between admission (30.4%) and before discharge (8.7%) in the experimental group ($P < .05$).

Conclusion: These findings suggest that comprehensive postural instructions and ROM exercises via educational videos during inpatient rehabilitation for subacute stroke patients could improve motor recovery and limit shoulder injury in stroke patients with hemiplegia. (J Manipulative Physiol Ther 2018;41:665-671)

Key Indexing Terms: *Stroke; Hemiplegia; Rehabilitation; Shoulder Injuries*

Introduction

Hemiplegic shoulder pain (HSP) is a common morbidity after a cerebrovascular insult.[1-3] The pain can occur in the early weeks after stroke, but more typically develops 2 to 3 months after stroke.[4,5] Hemiplegic shoulder pain has negative effects on rehabilitation outcome, hospital stay, and quality of life after stroke.[3,6-10] However, the mechanism leading to HSP development is not well understood. Multiple factors contribute to HSP. Rotator cuff injury is considered an important contributing factor in poststroke HSP at the subacute stage.[11-13]

Rotator cuff injury more frequently occurs in stroke patients with a flaccid shoulder because of impaired sensory and motor function of the hemiplegic shoulder.[9,14,15] Poor

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hemiplegic shoulder function can impair protection function, increasing the propensity for traction injury during activities of daily living and rehabilitation.[1] Therefore, several interventions, including adequate positioning and transferring, proper passive range of motion (ROM), and neuromuscular stimulation, have been proposed to prevent HSP or decrease further soft tissue injury.[16-20]

Previous studies showed that proper positioning for the hemiplegic shoulder was effective in preventing shoulder subluxation, which may be a cause of HSP.[21-24] For stroke patients with hemiplegia, greater shoulder pain was associated with overhead pulley exercise, and therefore active shoulder ROM exercise and a gentle approach have been the preferred therapies.[17] However, no study has evaluated soft tissue injury of the hemiplegic shoulder after these interventions in stroke patients with hemiplegia. Therefore, we considered that combined comprehensive postural instructions and correct ROM exercises before participating in inpatient rehabilitation or daily activities may be more beneficial for preventing the occurrence of shoulder soft tissue injury or pain in subacute stroke patients with flaccid shoulders. The aim of this study was to investigate the effect of video education of combined comprehensive postural instructions and ROM exercises on shoulder injury prevention and motor function during daily activities and rehabilitation in subacute stroke patients with hemiplegic shoulders.

Methods

Participants

Forty-eight patients (30 men and 18 women) who were diagnosed with acute stroke and had been admitted to the rehabilitation ward of Chang-Gung Memorial Hospital Kaohsiung Medical Center were recruited. Inclusion criteria included acute stroke resulting in unilateral hemiplegia of the upper limbs with Brunnstrom motor recovery stage I, II, III, or IV and no shoulder pain within 6 months before stroke onset.[25] The diagnosis of stroke was further confirmed using either brain computed tomography or magnetic resonance imaging. We excluded patients who had a history of prior stroke before this episode, severe cognitive impairment or aphasia leading to difficulty in communication, previous shoulder injury or surgery, frozen shoulder, shoulder musculoskeletal disorder, or neuromuscular diseases leading to shoulder weakness.

Study Design

This was a prospective cohort study designed to observe the effect of comprehensive postural instructions and ROM exercises with video education on patients with hemiplegic shoulder after acute stroke. Detailed information about the study was provided to and written informed consent was obtained from all participants. The study was approved by the institutional review board of Chang-Gung Memorial Hospital Kaohsiung Medical Center (#96-0564B). The clinical trial was registered using the Protocol Registration and Results System (at ClinicalTrials.org) with registration code NCT03045432.

Interventions

After admission to the rehabilitation unit, all patients participated in a standard inpatient rehabilitation program including active and passive ROM exercises, strengthening exercises, hand function training, transferring training, balance training, and ambulation training. The rehabilitation program consisted of 1 hour of physical therapy and 1 hour of occupational therapy per day, 5 days per week during hospitalization.

Twenty-three hemiplegic stroke patients and their caregivers could regularly perform positioning and ROM exercises in addition to the routine rehabilitation program, and those patients were allocated in the experimental group. Twenty-five stroke patients were assigned to the control group because of difficulty in cooperating with the additional interventions for their caregivers. Both groups received 1 nursing education session about adequate ROM exercises for hemiplegic shoulders and proper transferring techniques while admitted to the rehabilitation unit. In the experimental group, 23 patients received additional education for hemiplegic shoulders, provided in the form of 3 viewings of a 15-minute educational video during the first week of admission, about proper shoulder positioning, including adequate external rotation while lying down and subluxation prevention while sitting, standing, or during ambulation; proper shoulder ROM exercises involved in all planes of motion; and transferring techniques during daily activities. The patients and their caregivers were instructed to perform ROM exercises for 15 minutes at each session, twice per day for 5 days per week during the hospital stay and to avoid lifting heavy objects and unsafe physical activities. After completing video education, participants' skills were reassessed by the physical therapist and followed up during hospitalization.

Outcome Measures

We recorded clinical characteristics for each patient at admission, including age, sex, body weight, height, side of hemiplegia, type of stroke, and duration from stroke onset. Physical findings including hemiplegic shoulder sensation, Brunnstrom motor recovery stage, shoulder subluxation, shoulder passive ROM, and numeric pain scale (NPS) score (score 0 indicating no pain; score 10, the worst pain) for HSP were all assessed by the physical therapist upon admission. Shoulder subluxation was defined as a gap of more than 1 finger breadth between the acromion and the humeral head. Spasticity was assessed using a 5-point Ashworth Scale (score 0 indicating no spasticity; score 4, the

Table 1. *Clinical Characteristics of Stroke Patients in the Control and Experimental Groups*

Patient Characteristic	Control Group (n = 25)	Experimental Group (n = 23)	*P*
Age, y, mean (SD)	61.7 (15.0)	54.3 (11.9)	.06
Sex, female/male, n	11/14	7/16	.33
Height, cm, mean (SD)	161.65 (8.3)	162.8 (8.5)	.68
Weight, kg, mean (SD)	62.46 (7.8)	69.42 (13.4)	.06
Stroke type, n (%)			
Infarction	18 (72)	14 (61)	.41
Hemorrhage	7 (28)	9 (39)	
Hemiplegic side, n (%)			
Left	19 (76)	12 (52)	.09
Right	6 (24)	11 (48)	
Duration since stroke	20.9 (11.8)	18 (8.4)	.63

SD, standard deviation.
χ^2 test for sex, stroke type, hemiplegic side. *T* test for age, height, weight.

strongest spasticity).[26,27] If the Ashworth score was less than 1, we concluded that no shoulder spasticity was present. Hemiplegic shoulder ROMs (flexion, extension, abduction, and internal or external rotation) were measured using goniometry. We used the NPS to assess HSP severity while resting or performing passive ROM exercises of the hemiplegic shoulder. An experienced physiatrist performed shoulder sonography with a 5- to 12-MHz linear-array transducer (t3000, Terason, Burlington, Massachusetts) and interpreted the images. All tendons of the hemiplegic shoulder including the long head of the biceps tendon, supraspinatus tendon, infraspinatus tendon, subscapularis tendon, and subacromial-subdeltoid (SA-SD) bursa complex were scanned in both longitudinal and transverse planes. All physical and shoulder sonographic evaluations for all participants were performed at admission and 3 weeks after intervention.

Statistical Analysis

SPSS software (SPSS 12.0, Chicago, Illinois) was used to analyze the collected data. Student *t* test was used to compare differences in age, height, weight, duration since stroke onset, ROM of hemiplegic shoulders, and NPS score of hemiplegic shoulder pain between the control and experimental groups upon admission and before discharge. Differences in sex; stroke type; hemiplegic side; sensation; the changes of motor recovery stage; shoulder subluxation; and spasticity, presence of shoulder pain, and sonographic findings were compared between the control and experimental groups using a χ^2 test. The threshold for statistical significance was set at $P < .05$.

Results

Upon admission, the clinical characteristics of the control and experimental groups were recorded and compared. The 25 patients (11 women and 14 men; mean age, 61.7 years) in the control group and 23 patients (7 women and 16 men; mean age, 54.3 years) in the experimental group demonstrated no statistically significant differences in age, sex, stroke type, hemiplegic side, and duration since stroke (Table 1). The physical findings of hemiplegic shoulder were compared in the control and experimental groups, and no significant differences in sensation, Brunnstrom motor stage of the arm, shoulder spasticity, presence and severity of HSP, or shoulder motion were observed upon admission (Table 2). Before discharge (Table 3), a significant difference was noted in Brunnstrom motor stage recovery of the arm between the experimental and control groups.

In the abnormal findings of shoulder sonography in the control group (Table 4), effusion, tenosynovitis, or tendinitis at the long head of the biceps tendon was found in 24% of patients upon admission and 52% of patients before discharge. In the supraspinatus tendon, tendinitis or a tear was noted in 12% of patients upon admission and 40% of patients before discharge. There were significant differences in the frequency of abnormal structural findings in the long head of the biceps tendon and supraspinatus tendon between upon admission and before discharge in the control group ($P < .05$). In the experimental group, effusion, tenosynovitis, or tendinitis at the long head of the biceps tendon was found in 30.4% of patients upon admission and 56.5% of patients before discharge. In the supraspinatus

Table 2. *Physical Findings at Admission in the Control and Experimental Groups*

Exam Finding	Control Group (n = 25)	Experimental Group (n = 23)	*P*
Sensation, n (%)			
Normal	8 (32)	9 (39.1)	.61 [a]
Impairment	17 (68)	14 (60.9)	.61
Brunnstrom stage			.39
Stage 1	5 (20)	4 (17.4)	
Stage 2	3 (12)	7 (30.4)	
Stage 3	14 (56)	11 (47.8)	
Stage 4	3 (12)	1 (4.4)	
Shoulder spasticity, n (%)	11 (44)	7 (30.4)	.33
Presence of shoulder pain, n (%)	14 (56)	16 (69.6)	.33
NPS score (0-10), mean (SD)	2.5 (2.8)	3 (2.8)	.5
Shoulder motion			
Flexion, mean (SD)	158 (22.9)	166.5 (19.1)	.19
Extension, mean (SD)	50.6 (12.5)	55 (9.2)	.18
Abduction, mean (SD)	160.4 (31.8)	168.2 (27.1)	.46
External rotation, mean (SD)	76.2 (18.9)	81.1 (14.2)	.32
Internal rotation, mean (SD)	82.2 (12.4)	83 (14.6)	.83

NPS, numeric pain scale; *SD*, standard deviation.
χ^2 test for sensation, shoulder spasticity, motor recovery, presence of shoulder pain. *T* test for NPS score, shoulder motion.
[a] $P < .05$.

tendon, tendinitis or a tear was noted in 39.1% of patients at admission and 52.1% of patients before discharge. In the SA-SD bursa, effusion or bursitis was noted in 30.4% of patients upon admission and 8.7% of patients before discharge. In the experimental group, significant differences were shown in the frequency of abnormal structural findings in the long head of the biceps tendon and SA-SD bursa between at admission and before discharge ($P <$ 0.05), but no significant difference was noted in the supraspinatus tendon ($P = .31$).

Discussion

The goal of this study was to assess the effect of comprehensive postural instructions and correct ROM exercises by video education during inpatient rehabilitation and daily activities for hemiplegic shoulder in subacute stroke patients. Kumar et al investigated the effect of different exercises for hemiplegic shoulders and found that stroke patients performing proper ROM exercises under the guidance of a therapist are at a low risk of developing shoulder pain.[17] Correct positioning and shoulder ROM exercises were effective and recommended for hemiplegic patients with shoulder subluxation and may reduce muscle contracture after acute stroke, which may contribute to HSP.[21-24,28] This was the first study to observe shoulder injury by sonography and motor recovery of the weakened shoulders after video education for proper techniques for positioning, transferring, and ROM exercises during the inpatient rehabilitation program. We found that comprehensive instructions for proper shoulder positioning, transferring techniques, and ROM exercises could significantly improve hemiplegic shoulder motor function and prevent further injury in the supraspinatus tendon and the SA-SD bursa for subacute stroke patients with hemiplegic shoulders during inpatient rehabilitation.

Johanna et al reported that more intensive exercise might provide more benefits for arm function improvement in stroke patients.[29] Mechanisms regarding neurological

Table 3. *Physical Findings Before Discharge in the Control and Experimental Groups*

Exam Finding	Control Group (n = 25)	Experimental Group (n = 23)	*P*
Improved Brunnstrom motor recovery, n (%)	9 (36)	15 (65.2)	.04 [a]
Shoulder spasticity, n (%)	12 (48)	9 (39)	.54
Presence of shoulder pain, n (%)	15 (60)	16 (70)	.50
Change of NPS score (0-10), mean (SD)	0.4 (2.7)	0.1 (2.4)	.51
Shoulder motion			
Flexion, mean (SD)	153.8 (27.7)	153.5 (30.7)	.97
Extension, mean (SD)	49.8 (14.2)	54.1 (11.6)	.26
Abduction, mean (SD)	148.5 (40.4)	149.7 (36.2)	.93
External rotation, mean (SD)	66.2 (28.5)	77.6 (14.2)	.08
Internal rotation, mean (SD)	84.2 (9.4)	85.7 (9.6)	.6

NPS, numeric pain scale; *SD*, standard deviation.
χ^2 test for sensation, shoulder spasticity, motor recovery, presence of shoulder pain. *T* test for NPS score, shoulder motion.
[a] $P < .05$.

Table 4. *Shoulder Sonographic Findings in the Control and Experimental Groups*

	Control Group (n = 25)			Experimental Group (n = 23)		
The Abnormal Findings of Shoulder Sonography	Admission	Discharge	*P*	Admission	Discharge	*P*
Biceps tendon (effusion, tenosynovitis, tendinitis, tear), n (%)	6 (24)	13 (52)	0.035 [a]	7 (30.4)	13 (56.5)	.034 [a]
Supraspinatus tendon (tendinitis, tear), n (%)	3 (12)	10 (40)	0.035 [a]	9 (39.1)	12 (52.1)	.31
Subscapularis tendon (tendinitis, tear), n (%)	4 (16)	3 (12)	0.655	2 (8.7)	5 (21.7)	.25
Subacromial-subdeltoid bursa (effusion or bursitis), n (%)	3 (12)	3 (12)	1.0	7 (30.4)	2 (8.7)	.025 [a]

χ^2 test for abnormal findings of shoulder sonography.
[a] $P < .05$.

improvement during acute stroke include ischemic penumbra function recovery, brain edema, and mass effect resolution. Furthermore, cerebral plasticity and cortical functional reorganization are affected in the following months after stroke onset. Among them, neuroplasticity is greatly influenced by use.[30] In our study, the patients and their caregivers were instructed to perform additional ROM exercise for half an hour, twice per day and 5 days per week during the inpatient rehabilitation program. Significant proximal upper-limb motor recovery improvement was observed in the stroke patients who received combined comprehensive postural instructions and performed ROM exercises. The more ROM exercise they practiced may contribute to better motor recovery of the affected upper limbs at the subacute stage after stroke, which is consistent with previous studies.

After acute stroke, the affected upper extremity has poor motor function, leading to soft tissue injury related to subluxation or traction injury while performing daily activities.[31,32] Najenson et al found that the prevalence of rotator cuff injury to the affected shoulder (40%) was higher than that of the unaffected shoulder (16%).[16] Rotator cuff tear demonstrated a linear trend with muscle weakness of the hemiplegic shoulder, and the severity of shoulder weakness was an independent factor for rotator cuff tear on the affected side.[31] Furthermore, the weakened shoulder after a stroke could not provide sufficient strength to prevent shoulder injury in daily activities, particularly during a subacute stroke rehabilitation program.[1] Pong et al also reported that recent stroke patients with poor upper-limb motor function were more prone to have shoulder soft tissue injury after a 2-week rehabilitation program.[33] A significantly higher frequency (85%) of shoulder soft tissue injuries was found in subacute stroke patients with poor hemiplegic shoulder function compared with those with good hemiplegic shoulder function during inpatient rehabilitation.[14] In 1 previous study, use of an overhead pulley led to a higher level of hemiplegic shoulder pain.[17] Thus, restrained ROM exercise is recommended for stroke patients with hemiplegia to improve the ROM without increasing the risk of shoulder pain or injury. In our study, we used combined comprehensive instructions, including proper positioning/transferring techniques and correct ROM exercises during daily activities and rehabilitation for stroke patients and their caregivers to prevent further shoulder injury or pain. For subacute stroke patients with hemiplegia, limited hemiplegic shoulder injury was found after the intervention, as indicated by shoulder sonography, but no obviously positive effect was observed after HSP reduction. More tendon injury was noted at the supraspinatus tendon in the control group, but no obvious increased prevalence of the supraspinatus tendon injury in the experimental group. We also found a reduction in the abnormal findings on the SA-SD bursa in the experimental group. These findings suggest that comprehensive postural and proper exercise instructions could effectively prevent further supraspinatus tendon injury and reduce the structural changes in the SA-SD bursa in subacute stroke patients during inpatient rehabilitation.

Shoulder sonography revealed a significantly higher prevalence of abnormal findings in the long head of the biceps tendon on hemiplegic shoulders after intervention in both the control and experimental groups. This result may be associated with more elbow flexion exercises for upper-extremity training performed during conventional rehabilitation. In this study, we did not discuss appropriate elbow exercises in the educational video.

Limitations

This study had several limitations. First, we recruited a small group of subacute stroke patients for this pilot study from only 1 rehabilitation center, which could not represent the experience of the entire stroke population. Second, we did not include correct techniques to perform elbow exercises in this video to impede the injury of the long head of the biceps tendon on hemiplegic shoulders. Third, the long-term effects of combined comprehensive postural instructions and ROM exercises for the hemiplegic shoulder could be investigated in the future.

Conclusion

The findings of this study demonstrate that video education with combined comprehensive postural instructions and ROM exercises could provide an effective intervention to promote upper-limb motor recovery and limit further shoulder soft tissue injury during inpatient rehabilitation and daily activities for subacute stroke patients with hemiplegic shoulders.

Funding Sources and Conflicts of Interest

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Contributorship Information

Concept development (provided idea for the research): Y.-C.H., C.-P.L.
Design (planned the methods to generate the results): Y.-C.H., C.-Y.C
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): Y.-C.H., C.-P.L.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): Y.-C.H.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): C.-Y.C., L.W.
Literature search (performed the literature search): H.-L.C., C.-W.C.
Writing (responsible for writing a substantive part of the manuscript): Y.-C.H., C.-Y.C.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): C.-Y.C.

Practical Applications

- Comprehensive postural instructions and range of motion exercises via educational videos were found to promote upper-limb motor recovery for subacute stroke patients with hemiplegic shoulders.
- Proper instructions for shoulder positioning and exercises could effectively limit further soft tissue injury on hemiplegic shoulders in subacute stroke patients during inpatient rehabilitation.

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