# Efficacy of Shoulder Slings in Shoulder Subluxation of Stroke Patients

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***Objective:*** *To assess the efficacy of the two types of shoulder slings in reducing shoulder subluxation in acute stroke patients.*
***Material and Method:*** *Twenty-one acute stroke patients with shoulder subluxation were assessed for the subluxation distance before and after wearing the slings by physical examination and radiological measurement. The comparison by radiological measurement was performed by two radiologists who were blinded to each other as well as to the types of sling used.*
***Results:*** *The mean difference of subluxation distance on the affected side after wearing the slings number 1 and 2 were 0.48 mm and 1.14 mm respectively on physical examination and 2.09 mm and 1.14 mm respectively on radiological assessment. There was no statistically significant difference of subluxation distance on either physical examination or radiological assessment ($p > 0.05$).*
***Conclusion:*** *There was no difference in efficacy of shoulder slings in reducing shoulder subluxation in acute stroke patients.*

***Keywords:*** *Efficacy, Shoulder sling, Shoulder subluxation, Stroke*

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Shoulder subluxation is a common upper extremity problem in stroke patients. The incidence has been reported from 17-81% depending on the duration of the stroke and the diagnostic measurement, either radiological diagnosis or clinical diagnosis[1,2]. If it were left untreated, the consequences that might follow would be shoulder pain[3], limitation of movement, injury to the neurovascular tissues around the shoulder joints and delayed neurological recovery after a stroke[4]. Several attempts have been tried to correct and prevent shoulder subluxation. The proper handling techniques while performing exercise of upper extremities or assisting the patients during transfer activity was acknowledged as of prime importance[5]. However, the attempt to position the head of the humerus in the glenoid fossa has also been investigated. The shoulder support devices were designed as wheelchair attachments for nonambulatory patients and shoulder slings for ambulatory patients. There are two different sling designs, widely used among medical schools in Bangkok. Therefore, the efficacy of these two slings was explored to assist clinical decision making before selection. The purpose of the present study was to explore the efficacy of these two slings by measuring the reduction of shoulder subluxation between the head of the humerus and the acromion process. The comparison between each sling was performed although the reduction of shoulder subluxation should not be different.

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## Material and Method

The present study had the prior approval of

the ethical committee of Siriraj Hospital, Mahidol University. The pilot study recruiting five patients was performed in order to determine the sample size.

***Subjects***

The patients who had their first stroke within 3 months after onset and had shoulder subluxation were included. The diagnosis of stroke was made clinically by neurologists according to the WHO criteria or by radiological imaging. The shoulder subluxation was defined as the distance between the head of the humerus and the acromion process more than 1 finger-breadth on physical examination. If the patients had bilateral weakness or previous shoulder pathology, they were excluded from the present study.

***Shoulder slings***

Number 1 was available commercially. The design had an arm cuff and vertical strap system to support the weight of the affected shoulder through the sound axilla. There were three sizes; small, medium, and large (Fig. 1). Number 2 was tailor made by an occupational therapist of the Department of Rehabilitation Medicine. The design had an arm cuff and figure eight strap system to support the weight of the affected shoulder through the sound axilla (Fig. 2).

***Procedures***

The following data were obtained from the patients, namely age, gender, risk factors, affected side, types of stroke and onset after stroke. The affected shoulder was examined to obtain range of motion, muscle tone, and power. The presence and degree of shoulder pain on movement was recorded on a visual analogue scale. Then the patient was positioned standing or sitting in a chair with back support and with both arms unsupported at the sides. The magnitude of shoulder subluxation was measured as the distance between the head of the humerus and the acromion process on physical examination. Two slings were worn randomly on the affected side. The time interval for allowing the shoulder to dangle at the side was no less than 5 minutes after wearing each sling. After completing the physical assessment, the patients received radiographic assessment at the Department of Radiology by using the same protocol.

***Measurements and comparison***

The following measurements were performed and compared as follows:

1. The magnitude of shoulder subluxation on physical examination and on plain film x-ray.
2. The magnitude of shoulder subluxation on physical examination before and after wearing each of the two slings (Fig. 3).
3. The distance between the acromion process and the head of the humerus was compared side to side on plain film x-ray (Fig. 4).
4. The magnitude of shoulder subluxation on plain film x-ray before and after wearing each of the two slings.

***Statistical analysis***

The SPSS version 11.5 was used in analyzing the data. A paired t-test was performed to compare the reduction of distance between the head of the humerus and the acromion process of the affected side on physical examination and on plain film x-ray before and after

**Fig. 1** Shoulder sling no. 1

**Fig. 2** Shoulder sling no. 2

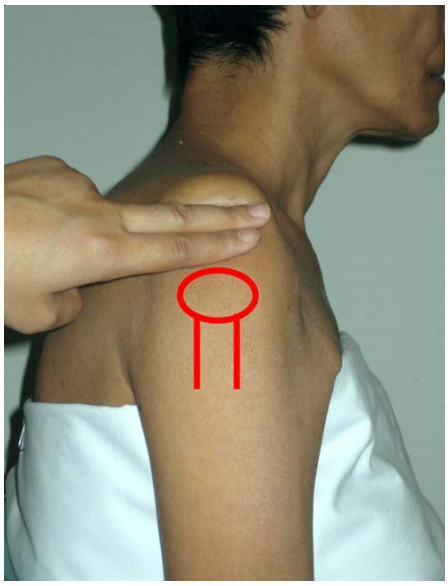

**Fig. 3** Shoulder subluxation distance between acromion process and head of humerus on physical examination

wearing each sling. The intraclass correlation was used to address reliability between two radiologists on radiological assessment. Kolmogorov-Smirnov test was used to explore the normality of data distribution. Wilcoxon Signed Ranks test was performed to compare the mean difference of the distance before and after wearing each sling measured on physical examination and on plain film x-ray. A p-value of less than 0.05 was considered significant.

**Results**

Twelve males and nine females aged 46-84 years old were included in the present study. The mean age was 62.7 years. Most of them had cerebral infarction and right side weakness for 8-83 days after a stroke. Most common risk factors were hypertension, dyslipidemia, smoking, diabetes mellitus, and heart disease, respectively (Table 1).

Nineteen patients had flaccid tone on the affected side (90%). Muscle power of shoulder flexion and abduction could be elicited in six patients (28.6%). Four and two of them had trace and poor muscle power respectively. Ten patients (47.6%) had a limited passive range of motion of the affected shoulder in all directions. Flexion, abduction, and rotation could be passively performed to 172, 167, and 85 degrees respectively. Shoulder pain was reported on shoulder motion with a mean score of 2 on the visual analogue scale.

On physical examination, the mean subluxation distance before wearing the sling was 26.43 mm which was reduced to 25.95 and 25.29 mm after wearing sling number 1 and 2 respectively (Table 2). The paired t-test between the subluxation distance before and after wearing the sling number 2 was statistically significant ($p < 0.05$).

On radiological assessment, the reliability of radiographic measurements between two radiologists was assessed and high reliability was reported. The mean distance between the head of the humerus and the acromion process on the normal side was 24.3 mm. On the affected side, the mean subluxation distance before wearing the sling was 39.9 mm which was re-

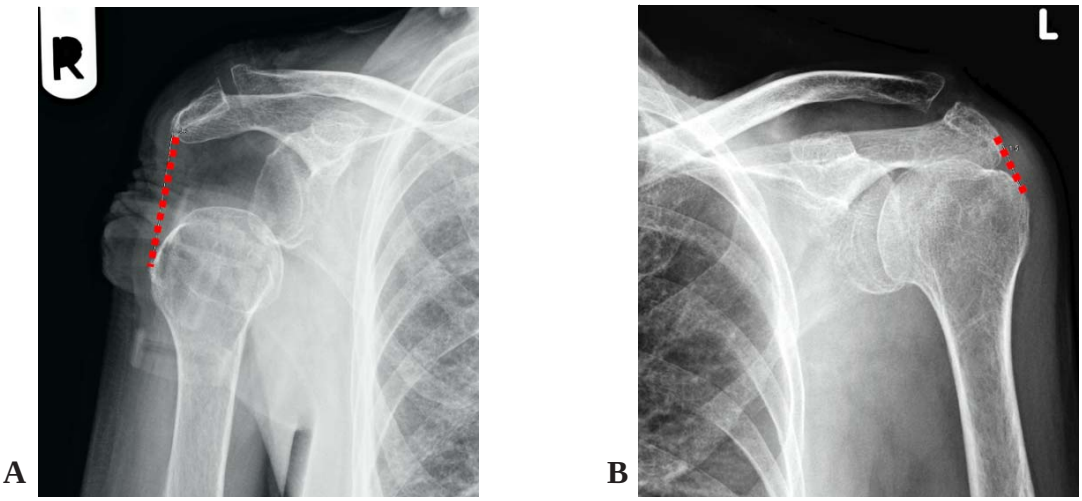


**Fig. 4** Radiological measurement between acromion process and head of humerus
A) shoulder subluxation of affected shoulder B) normal shoulder

duced to 37.81 and 38.2 mm after wearing sling number 1 and 2 respectively (Table 2). The paired t-test was not statistically significant ($p > 0.05$).

The mean difference of the subluxation distance before and after wearing the two slings was compared through the Wilcoxon Singed Ranks test. The magnitude of shoulder subluxation on physical examination after wearing slings number 1 and 2 was reduced 0.48 mm (SD = 1.50) and 1.14 mm (SD = 2.0) respectively and there was no statistical significance found between the two slings. The magnitude of shoulder subluxation was also measured by radiological assessment after wearing slings number 1 and 2 and it was reduced 2.09 mm (SD = 5.71) and 1.14 mm (SD = 6.73) respectively and there was no statistical significance (Table 3).

**Table 1.** Demographic data

| Characteristics | Number (percent) |
|---|---|
| Gender | |
| Male | 12 (57.1%) |
| Female | 9 (42.8%) |
| Mean age (years) | 62.7 ± 10.82 |
| Risk factors | |
| Hypertension | 14 (66%) |
| Dyslipidemia | 13 (61%) |
| Smoking | 9 (42%) |
| Diabetes Mellitus | 6 (28%) |
| Heart disease | 1 (4.8%) |
| Types of stroke | |
| Infarction | 19 (90%) |
| Hemorrhage | 2 (10%) |
| Affected side | |
| Right | 14 (67%) |
| Left | 7 (33%) |
| Muscle tone | |
| Flaccid | 19 (90%) |
| Spastic | 2 (10%) |

## Discussion

Shoulder subluxation has been defined as having a distance between the head of the humerus and the acromion process of more than 1 fingerbreadth on physical examination[6,7]. It may result from an abnormal muscle tone after a stroke especially in the flaccid stage[8]. Decreased muscular support at the glenohumeral joint could be a great contributor since the integrity of the glenohumeral joint is maintained by rotator cuff muscles[9]. In the present study, most of the patients had muscles on the affected side in the flaccid stage. Some patients had muscle strength in shoulder flexion and abduction. However, the strength was insufficient to counterforce the weight of the affected arm. Brunnstorm motor recovery of more than grade 3 is enough to counterforce the shoulder subluxation[7]. Mild shoulder pain was reported in patients who had limitation in passive shoulder motion. Shoulder subluxation and pain may occur together but no causal relationship exists between them[10]. The limita-

**Table 2.** Mean subluxation distance on physical examination and plain film x-ray before and after wearing each sling (n = 21)

| Shoulder slings | Physical Examination (mm) | p-value | Radiological Assessment (mm) | p-value |
|---|---|---|---|---|
| Without sling | 26.43 ± 6.15 | | 39.90 ± 7.40 | |
| Sling no. 1 | 25.95 ± 5.62 | 0.16 | 37.81 ± 10.07 | 0.108 |
| Sling no. 2 | 25.29 ± 5.32 | 0.02* | 38.76 ± 8.90 | 0.446 |

Significant at p-value < 0.05

**Table 3.** Mean difference of subluxation distance after wearing each sling measured on physical examination and on plain film x-ray (n = 21)

| Shoulder slings | PhysicalExamination (mm) | RadiologicalAssessment (mm) |
|---|---|---|
| Sling no. 1 | 0.48 ± 1.50 | 2.09 ± 5.71 |
| Median [Min, Max] | 0 [0,5] | 2 [-15,10] |
| Sling no. 2 | 1.14 ± 2.00 | 1.14 ± 6.73 |
| Median [Min, Max] | 0 [0,5] | 1 [-17,15] |
| p-value | 0.063 | 0.38 |

Significant at p-value < 0.05

tion of motion in all directions may be an early sign of adhesive capsulitis. This is often a cause of post stroke shoulder pain[11].

Shoulder support devices have a variety of designs and are commercially available. Yet, there has been insufficient evidence to conclude whether slings and wheelchair attachments prevent subluxation, decrease pain, increase function, or adversely increase contracture in the shoulder after a stroke[12]. However, appropriate selection of the type of supportive device for the patient and clearly defining the purpose of its use should be thoroughly considered[13]. Additionally, regular follow up check and the time to stop using the sling should also be born in mind. Although radiological measurement has been used to assess the efficacy of these devices, several techniques were performed and no standard technique has been established to measure the magnitude of shoulder subluxation after a stroke. In the present study, physical examination was one of our measurements since it could be performed at the bedside. Therefore, the more sensitive radiological measurement was performed in parallel[14]. The authors measured the distance between the head of the humerus and the acromion process on plain film x-ray in a similar way to the distance measured on physical examination. Before wearing the slings, both arms were left unsupported at the sides for no less than 5 minutes in order to allow the gravitational pull on the poorly supported glenohumeral joint to take effect the same as when the patient was in a walking position. The random selection of the slings for each patient meant there was no effect from the order of the slings used. Although the comparison performed on physical examination revealed statistically significant reduction of subluxation distance after wearing sling number 2, the reduction of 1-2 mm of subluxation distance was not considered clinically significant. Therefore, the type of sling used did not matter. The mean difference of subluxation distance after wearing each sling measured on physical examination and on plain film x-ray showed no correction to overcorrection. Therefore, the clinician had to keep in mind that the sling might contribute to overcorrection of the subluxation distance, which caused an impingement between coracoacromial arch and greater tuberosity of humerus[15]. Then the patient would have shoulder pain. Hence, the thorough consideration is essential for prescription of shoulder slings in stroke patients. Additionally, other factors that might assist clinical decision making could be cost effectiveness, cosmetic appearance and the ease of application.

**Conclusion**

There was no clinically significant difference in the efficacy of shoulder slings in reducing shoulder subluxation in acute stroke patients. Neither sling had any effect in reducing the magnitude of subluxation. Hence, shoulder slings should not be uniformly applied to all stroke patients with shoulder subluxation. Correct handling and full passive movement should be integrated early in the program.

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## ประสิทธิภาพของอุปกรณ์ประคองข้อไหล่ในผู้ป่วยโรคหลอดเลือดสมองที่มีข้อไหล่หลุด

**ปิยะภัทร เดชพระธรรม, เพ็ญแข สุระ, นิตยา เล็กตระกูล, กุลนุช ชาญชัยรุจิรา**

***วัตถุประสงค์:*** *เพื่อศึกษาประสิทธิภาพของอุปกรณ์ประคองข้อไหล่ 2 ชนิดในผู้ป่วยโรคหลอดเลือดสมองที่มี ข้อไหล่หลุด*
***วัสดุและวิธีการ:*** *ผู้ป่วยโรคหลอดเลือดสมองที่เป็นครั้งแรกและมีข้อไหล่หลุด ภายในระยะเวลา 3 เดือน ได้รับการตรวจร่างกายและถ่ายภาพเอ็กซเรย์ข้อไหล่ด้านดีเทียบกับด้านที่ข้อไหล่หลุดก่อนและหลังใส่อุปกรณ์ประคองข้อไหล่ทั้ง 2 ชนิด รังสีแพทย์ 2 คนทำการวัดช่องว่างของข้อไหล่ก่อนและหลังใส่อุปกรณ์ประคองข้อไหล่โดยไม่ขึ้นแก่กันและไม่ทราบชนิดของอุปกรณ์ประคองข้อไหล่*
***ผลการศึกษา:*** *ความแตกต่างเฉลี่ยของช่องว่างข้อไหล่ด้านที่ไหล่หลุดเมื่อใส่อุปกรณ์ประคองข้อไหล่ชนิดที่ 1 และ 2 จากการตรวจร่างกายมีค่าเท่ากับ 0.48 และ 1.14 มิลลิเมตร และจากภาพเอ็กซเรย์มีค่าเท่ากับ 2.09 และ 1.14 มิลลิเมตร ตามลำดับ ซึ่งไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ*
***สรุป:*** *ประสิทธิภาพของอุปกรณ์ประคองข้อไหล่ทั้ง 2 ชนิด ไม่มีความแตกต่างกัน ในการลดภาวะไหล่หลุดของผู้ป่วยโรคหลอดเลือดสมอง*