CHAPTER III

METHODS

1. Participants

Thirty-eight patients with hemiplegia were recruited from rehabilitation hospitals in Thailand. All patients signed an informed consent before entry to the study. The experimental protocol was approved by the ethical research committee of the Faculty of Associated Medical Sciences, Chiang Mai University. Age, gender, weight, height, diagnosis and onset of hemiplegia were recorded for each subject.

Subjects with shoulder pain were defined as patients who have shoulder pain associated with movement. If hemiplegic patients informed pain, they were classified as a shoulder pain group (n=19). Patients who have no pain were classified as a without shoulder pain group (n=19). Age and sex were matched in each group.

1.1 Inclusion criteria

1. First hemiplegia from any causes both genders, aged 18-80 years.
2. Duration after hemiplegic onset less than one year.
3. Ability to comprehend and to score a abilityQ as being able to answer either verbal or VGRS questions correctly and completed serial records consistently.
4. Ability to sit independently without arm support for at least 30 minutes.

1.2 Exclusion criteria

1. History of shoulder diseases or pain before hemiplegic onset. For example, limitation of range of motion, arthritis, dislocation or any surgery associated with shoulder girdle.
2. Had shoulder hand syndrome or pain from non-mechanical mechanisms (oedema, limited range of motion, sweating, trophic skin changes, discoloration, nails and hair changes) (64).
3. Patients have Modified Ashworth Scale (MAS) of the shoulder adductors greater than 2 in the sitting position.
4. Had marked thoracic kyphosis.
5. Had scoliosis.

2. Variables

2.1 Independent variables

1. Affected side hemiplegia with shoulder pain
2. Affected side hemiplegia without shoulder pain

2.2 Dependent variables

1. Scapular horizontal position (Sc-hor) (mm.)
2. Scapular vertical position (Sc-ver) (mm.)

3. Scapular rotation at resting position (Sc-rot-rest), scapular rotation at 90° of passive arm elevation (sc-rot-90) and scapular rotation at 140° of passive arm elevation (sc-rot-140)

4. Length of pectoralis minor muscle (Pect-mi) (mm.)

5. Length of pectoralis major muscle (Pect-ma) (degree)

6. Length of shoulder external rotator muscles (Ext-rot) (degree)

7. Length of shoulder internal rotator muscles (Int-rot) (degree)

8. Thoracic kyphosis index (T-kypho)

9. Humeral inferior gliding (Hu-inf) (mm.)

3. Equipments

1. A thermoplastic jig as described in Hayes et al. (27)
2. Circular markers with 1 cm. diameter. The center of marker was defined using two lines which were drawn on a marker.
3. A digital camera (Sony Cyber-short mpegmovie VX smart zoom DSC-P93A)
4. A camera tripod
5. A universal goniometer
6. A gravitational goniometer
7. An inclinometer
8. A special chair
9. A flexible ruler

10. A standard ruler

11. A pole for maintain shoulder elevation in scapular plane

4. Experimental setup

4.1 Measurement of shoulder pain

Shoulder pain was evaluated using a modified shoulderQ questionnaire (52). The subjects were identified by the modified AbilityQ as being able to answer either verbal or VGRS questions correctly, completed serial records consistently. The ShoulderQ appeared to detect fluctuations in pain experience appropriately. Only patients with shoulder pain resulted from mechanical mechanism were recruited.

4.2 Measurement of muscle tone

Muscles tone were measured using MAS (25, 65). Muscle tone defines as the resistance of muscle being passively lengthened or stretched. Muscle tone was measured on the affected side of patients in the sitting position.

4.3 Measurement of upper limb function

Most patients with hemiplegia can not perform the isolated joint action and may have muscles paralysis or weakness. These problems made the objective measurement of muscles strength difficult. Since muscle strength is one of the muscular elements which may affect movement and pain. The present study indirectly assessed muscle strength using the functional movement tool. The Motor Assessment Scale of the upper limb function was used (66).

4.4 Muscles length measurement

Muscles length were measured on the affected side. Muscle length may be limited by resistance or pain, which was recorded for each subject.

a. Pectoralis minor muscle

Muscles length of pectoralis minor was tested in the supine position. The distance between a treatment table and the anterolateral angle of the acromion (ALA) was measured using a standard ruler.

b. Pectoralis major muscle

Muscles length of pectoralis major was tested in the supine position. The sternal part of pectoralis major was evaluated by placing an arm in a position of shoulder abduction at 135º, external rotation with elbow extension. The maximal passive range of shoulder abduction with the arm remained flat on a table was recorded in degrees. The axis of a goniometer was at the lateral tip of acromion process, a stationary arm of a goniometer was lied parallel to a supporting surface and a moving arm was positioned along midline of the humerus toward the lateral epicondyle.

c. Internal and external rotators of the shoulder

Muscle length of the shoulder internal and external rotators were measured in the supine position with the shoulder abduction 90°, and the elbow flexion 90°. Muscles length of internal rotator were examined in the external rotation of the shoulder. Muscle lengths of external rotators were tested in the internal rotation of the shoulder. The

passive range of shoulder external and internal rotation without compensatory movements was recorded in degrees using a gravitational goniometer.

4.5 Shoulder complex alignment measurement

The shoulder complex alignment was measured on the affected side. Subjects were seated in the special chair. The chair had a back support lower than inferior angle of scapula, and a chest support for stabilizing position. The chair was adjusted so that subjects were seated with their feet flat on the floor with a knee angle of approximately 90°. For the scapular kinematics, a photography method was used. A digital camera with a tripod was set perpendicular to the plane of movement (approximately 30° anterior to the frontal plane). The distance between subjects and a camera was at least 1 meter. A 5-centimeter ruler was attached to the back of subjects and was used to calibrate the linear displacement from the photograph using an Image tool program.

a. Scapular rotation measurement

Scapular rotation was calculated from angle between the spine of scapula and the horizontal level during resting position, at 90° and 140° of passive arm elevation. Subjects were passively elevated their arms in the scapular plane with the elbow extension and forearm in neutral position. A pole was used as a visual cue for maintain arm alignment in the scapular plane during passive elevation. Passive humeral elevation angle was determined using an inclinometer which was attached on the upper arm. Scapular rotation was measured using a photography technique. A circular marker with one centimeter diameter was attached at the root of spine of the scapula and at the

postero-lateral border of the acromion process. Palpation of the bony landmark and attachment of markers were performed at specific angle of shoulder elevation. A digital photograph was taken at each defined angle. Image tool program was used to digitize the position of a marker and the angle of scapular rotation was calculated.

b. Scapular horizontal position

The scapular horizontal position was measured from a horizontal line between the root of spine of the scapula and the spinous process of thoracic spine which was at the same level of the root of spine. The scapular horizontal position was measured from a photograph which was digitized using an Image tool program.

c. Scapular vertical position

The scapular vertical position was defined as the vertical length between the superior angle of the scapula and the spinous process of C7. The vertical position of scapula was determined from a photograph which was calculated using an Image tool program.

d. Humeral inferior gliding (27)

The thermoplastic jig was used to assess humeral inferior gliding. Subjects in a seated position was marked the location of acromion with a pen. Then, after subjects were passively flexed the elbow joint at 90°, the short leg of the jig was placed under the subject's elbow and made a dot through a hole in the long arm of the jig 20 cm above the subject's olecranon. The investigator then places the short leg of the jig on the acromion mark, move the beak to the dot on the arm, and fix the beak. The point at which the slide

portion of the beak rested on the tape measure was read and recorded in millimeters. The patient was flexed the elbow, and the investigator manually reduced the shoulder subluxation. The measurement of the distance between the acromion and the dot on the arm was then repeated. The amount of subluxation was the difference, in millimeters, between the two measurements.

e. Thoracic kyphosis index (39)

The curve of the thoracic spine was determined by locating the T1 and T12 vertebrae by palpation, marking these spinous processes with a pen, and placing a flexible ruler along the contour of the spine between these landmarks. The ruler was marked at T1 and T12 before removing it from the subject. Thoracic kyphosis index is the depth × 100 / the height.

5. Experimental protocol

Subjects were screened for the suitable inclusion and exclusion criteria. They were measured in the following order.

1. MAS_{UL} (level 1-3) was tested in the supine position.

2. Measurement of muscle length in the supine position, starting from pectoralis minor, pectoralis major, shoulder internal rotators and external rotators.

3. Subjects were asked to sit in a suitable chair and scapular horizontal and vertical position as well as thoracic kyphosis index were measured.

4. In the seated position, humeral inferior gliding was also determined.

5. Scapular rotation at resting position and during passive arm elevation at 90 and 140 degrees were assessed.

6. MAS_{UL} (level 4-5) was tested in the sitting position.

7. MAS_{UL} (level 6) was tested in the standing position.

6. Reliability of measurements

Prior to the real data collection, a reliability study was performed in 8 healthy subjects. Intra-tester reliability was determined using the intra-class correlation coefficients. Subjects were tested twice within a few days.

7. Statistical analysis

Analyses were undertaken using the Statistical Package for the Social Sciences (SPSS) and all statistical tests were performed at the 5% level of significance. Between subjects comparison was tested using independent-t-test to compare all dependent variables as well as upper limb function between hemiplegic shoulder with and without pain.

8. Location

The study was conducted at the Department of Physical Therapy, Faculty of Associated Medical Sciences, Chiang Mai University; the Chiang Mai Neurological hospital, the Nakornping hospital, the McCormick hospital, the Chiang Mai Ram hospital in Chiang Mai province as well as the Thai Red Cross Rehabilitation Center and the Samutprakran hospital in Samutprakran province.