CHAPTER III
METHODS

Participants

Twelve participants (aged 40-70 years) were recruited from hospitals and nursing home in Chiang Mai province. Prior to participating in the intervention, the patient signed an informed consent. The experimental protocol was approved by the ethical research committee of the Faculty of Associated Medical Sciences, Chiang Mai University. After being recruited, the participants were evaluated baseline and post-intervention information of this study. The post-intervention data was used to assess the success of the circuit training treatment as compared to the baseline data.

Inclusion criteria

1. First time stroke with the onset of stroke more than six months.
2. Ability to move actively at least 30 degrees of the shoulder flexion and abduction, and 15 degrees of the shoulder lateral (external) rotation.
3. Ability to move actively at least 30 degrees of the elbow flexion and extension and 10 degrees of the wrist extension in seated position.
4. Ability to perform the circuit training independently and safely.

Exclusion criteria

1. Had peripheral nerve or orthopedic condition that involved arm movement.
2. Had cardiac disease that limited function, such as dyspnea, angina, severe fatigue or uncontrolled hypertension.
3. Severe aphasia, neglect, depression that could limit participation.
4. Participating in any experimental drug, field study or in the formal upper extremity rehabilitation program.

Evaluation

The following tests were administered to all participants in the study. All tests, except the administrative test, carried out four times at four and two weeks and one day before intervention program and one day after the completion of the treatment program. The same tester performed all measurements and used the same procedure and standardized tests.

Administrative test

Administrative test collecting patient characteristics such as age, dominant hand, stroke history, rehabilitation history and comorbid health conditions will be recorded. The administrative test was recorded only once before the intervention (Appendix A).

Strength and spasticity assessment

Continuous passive movement (CPM) mode of isokinetic tests was used to assess muscular strength and spasticity in the present study. Strength assessment was also measured using the isokinetic dynamometer (Contrex MJ Multijoint System). The torque caused by the weight of the arm and hand was first measured for gravitational corrections. The arm of the machine moved with constant velocity throughout the available range of motion of the patient. The patient could follow passively the movement of the machine; they could work (concentrically) with the machine. After a few pretest trials to get accustomed to the dynamometer and after movements at submaximal efforts to warm up, series of repeated measurements of peak torque were collected. Peak torques of flexors and extensors of the shoulder, and the elbow, the wrist were recorded. The peak torque of movement was collected from the unaffected UE with two minutes rest between testing action. Data were compared between the baseline and post training. Spasticity assessment of the elbow flexor muscles was also measured using the isokinetic dynamometer. The examiner instructed the subjects to relax, then passively extended the elbow with the CPM mode at speed 120/sec. Data from three trials were gathered from the affected arm, each trial separated by a 30-second rest to minimize inter trial effects.

Active range of motion assessment

Maximum active range of motion (AROM) of the shoulder flexion/extension, the elbow flexion/extension and the wrist flexion/extension were measured using an electrical goniometer (Biometrics R4002). A pilot study of the reliability of the AROM was performed in ten patients with stroke. The reliability of the shoulder flexion/extension, the elbow flexion/extension and the wrist flexion/extension was good (ICC> 0.9) as assessed using an electrical goniometer (Appendix C).

Modified Wolf Motor Function Test (mWMFT)

The mWMFT was preferable to the commonly used UE performance tests because it tested a wide range of functional tasks (arranged in order of complexity, progress from the proximal to the distal joint involvement) and explored both performance time and quality of movement. The mWMFT, which included 15 functional tasks (Appendix D) was measured in a clinical environment. Performances were timed and rated using a 6-point functional ability scale. The first to sixth task of the mWMFT involved joint-segment movements, and the seventh to fifteenth task consisted of integrative functional movements.

The Motor Activity Log (MAL)

The MAL consisted of a structured interview the patient to assess the use of the paretic arm and hand during activities of daily living. It measured how subjects perceived their functions in the home environment. The MAL was an ordinal scale that identified performance on 26 daily activities, which evaluated “how much” (quantity) and “how well” (quality) (Appendix E). Each patient was asked how much the affected arm participated in this activity. Possible scores range from zero (never use the affected arm for this activity) to five (always use the affected arm for this activity). To measure quality, the patient was asked how well the affected arm helped during this activity. Possible scores range from zero (inability to use the affected arm for this activity) to five (ability to use the affected arm for this activity just as well as before the stroke).

Training procedures

Training consisted of four sessions per week, for six weeks. Subjects had to attend the training at least 21 from 24 sessions. Participants spent 90 minutes to perform seven stations of circuit training. Resting time in each station provided as needed. During the training period, the blood pressure was measured. If the systolic blood pressure was higher than 200 mmHg (56), the training was stopped. One occupational therapist and one physical therapist conducted the intervention program. Circuit training consisted of 7station.

Station 1: Stretching exercise (Appendix F)

This station consisted of eight actions for stretching the spastic affected shoulder, elbow, and wrist muscles until the available range of motion was reached. The stretches were held for least 30 seconds /action with 4 repetitions for each position.

- Pectorals stretch

The action consisted of slowly raise both arms above the head and reaching as high as possible. This action stretched the pectoralis major muscle.

- Posterior deltoid stretch

The action consisted of grasping an affected arm behind the elbow joint with the opposite hand. Slowly pull the arm in front of the body. This action stretched supraspinatus and posterior deltoid muscles.

- Scapular stretch

The action consisted of cross both arms in front of chest and placed each hand around the opposite shoulder and slowly stretch hand towards middle of the back as far as possible. The Scapular stretch worked on the rhomboid muscles.

- Weight bearing

The participant seated in an upright position and shifted the body weight through the affected arm in a position contrary to the typical pattern of spasticity. The action stretched the pectoralis, biceps brachii and wrist flexors.

- Forearm stretch

The participant seated or standed in an upright position with an affected arm straight in front of the body, and the palm facing up. With the less affected hand grasped the fingers and slowly pull them down (extend wrist and fingers) toward the floor. The forearm stretch worked on the wrist flexors.

- Anterior deltoid stretch

The action consisted of grasping hands together behind the back. Then slowly raised both hands and arms up. This action stretched the anterior deltoid muscle

- Biceps stretch

The movement consisted of placing the palm, of an affected arm against the wall or using elastic band. The elbow fully extended and slowly turned the body around, until the biceps brachii muscle was stretched.

- Triceps stretch

The triceps stretch worked on the triceps brachi muscle. It was completed in a few simple motions. Patients were seated in an upright position with the affected hand resting on the shoulder of the same side and slowly raise the elbow up until it was positioned beside the ear. The less affected hand held the elbow for support.

Station 2: Self active exercise of the shoulder and the arm

Training sessions consisted of three positions of the shoulder exercise and five positions of arm and the wrist exercises. Shoulder exercise consisted of 1) elevation of the scapular 2) circumduction of the shoulder in a forward direction. 3) retraction and protraction of the scapular. Self active exercise starting with participant clasped their hands with fingers entwined; an affected thumb was on top. Arm exercise consisted of 1) raising hands over the head, keeping elbows straight 2) stretching arms in front of a body at the shoulder level, twisting arms to the pronation, then to the supination. 3) with elbows bent and hands clasped at chest, patients bent the wrist to the flexion, then to the extension 4) placed clasped-hands on the knee, then raised them to the opposite shoulder. 5) Rotated the wrist in a slow circular motion. Each action performed two sets of 20 repetitions.

Station 3: Bilateral arm training

Participants were seated, with the trunk stabilize during arm movement, that is, shoulder flexion with elbow extension and shoulder extension with elbow flexion. Subjects grasped on the bar handle that moved with no resistance in the transverse plane. A participant's hand was strapped if patient could not grasp independently. Participants then pushed the handles away from them and then pulled the handles toward them with two arms moving together or alternately. Training sessions consisted of repetitive 10 times/set for three sets. Two minutes resting periods between set was allowed.

Station 4: Repetitive sensory training

Patients were positioned in crawling or sitting. The affected arm was supported by a long air splint in a position contrary to the typical pattern of spasticity and the hand was placed on a floor near a balance board. The patients placed the hemiplegic arm on a balance board and actively pushed it. The balance board was then allowed to move back to the starting position. Patients performed 20 repetitions/sets for two sets with two minutes resting periods between a set. This experimental intervention emphasized motor stimulation through the repeated movements facilitating muscle activity and sensory stimulation.

Station 5: Repetitive task-specific training

Twenty minutes of therapy concentrated on training affected limb in functional tasks which were chosen by patients and the therapist. Tasks were designed to be standard, repeatable, and meaningful (e.g. drinking from glass, opening a bottle, writing, combing hair, using a spoon, block placement). Task could be performed within level of available voluntary motion. Each task was subdivided by the trainer into a hierarchy of component movements that progress in complexity to minimize failure or frustration. If patient could not grasp, they could use an assistive device for doing function. The goal was incremental progress on tasks beyond motor ability of patients through assignment of progressively more difficult tasks or many repetitions.

Station 6: Bilateral isokinetic training

Strength training involved reciprocal elbow extension and flexion movements on the arm ergometer which controlled the velocity and power of concentric muscle action. Subjects seated on the machine and performed three sets of two minutes training in 50% of power average which was measured by an isokinetic dynamometer. Training intensity was adjusted every two week by increasing to 60-70% of maximum torque.

Station 7: Strength training exercise

The shoulder, the elbow and the wrist movements were progressively performed against resistance using free weight or theraband strips in three positions 1) elbow flexion 2) elbow extension 3) shoulder abduction. Subjects performed three sets (eight to ten repetitions per set) at 60% of maximum torque. Training intensity was adjusted biweekly by increasing to 70-80% of maximum torque.

Data analysis

All outcome data were analyzed with a statistical software package. A repeated measures analysis of variance (ANOVA) was used to determine whether differences existed across pre-assessment data. A pretest-posttest design was used and a paired t-test of each outcome was performed with a significance level at $P<0.05$.