The Impact of Functional Electrical Stimulus and Proprioceptive Neuromuscular Facilitation to Scapula Adductor on Upper Limb Functions and Gait of the Patients with Stroke

The present study examined the effects of functional electrical stimulus (group 1), proprioceptive neuromuscular facilitation (group 2) and combined training of functional electrical stimulus and proprioceptive neuromuscular facilitation (group 3) with scapula adductor muscles on scapula movement, upper limb function and gait in fifteen subjects stroke patients.

The training was thirty minutes a day, five times a week for six weeks, obtained result as follow, upper limb function was significant difference in the group 2(p<0.05) but no significant difference in other groups.

The change of weight bearing were significant difference in all the groups(p<0.05), and increase of gait velocity were significant difference in all the group(p<0.05).

In conclusion, when applied with functional electrical stimulus, proprioceptive neuromuscular facilitation and combined training to the scapular adductor muscles, it was observed in the course of the experiment that proprioceptive neuromuscular facilitation was the most effective treatment among the three methods applied to the scapula adductors.

Key words: Functional Electrical Stimulus: Proprioceptive Neuromuscular Facilitation: Scapular Movement: Stroke

INTRODUCTION

Jorgensen et al, suggested that in the recovery process from stroke, the motor functions of the upper and lower limbs reaches the stabilized phase within 3–6 months(1), and stroke is the major cause for the impairments in adults, typically accompanying loss of motor function(2). One of the major causes to disturb the motor function is the muscle weakness, which is also the major cause for the physical disability in the patients with stroke(3) and usually occur in the non-paralyzed part as well as the paralyzed part(4, 5).

Pattern and colleagues asserted that such muscle weakness can be primarily attributed to the reduced or changed neuronal activities and secondarily to neuronal inactivity, the muscle atrophy due caused by the reduced muscular activity and the change in the compositional ratio in the muscle fibers(6).

Another major cause that disturbs the motor function is hypertonicity, which occurs as an almost common problem both in the upper and lower limbs after the stroke attack: causes the physical disability and pain(7); results in the increase in muscle tone due to the nonsuppression of the regulating mechanism for the muscle tone; reduces the range of motion(ROM) in the affected limbs(8). Consequently, the wrong proprioceptive input may disturb the movement of motion, which results in the disturbance in the limb motions(9).

Hypertonicity often causes in the retraction in scapula, According to Paine and Voight(10), the muscles around the scapula should be line up for the shoulder stability and these muscles should be located in the dynamically position to facilitate the movements of glenohumeral joint. In addition, Ellenbecker and Davies propose that the movement of one joint affects other proximal and distal part(11). It is known that various factors including muscle weakness and
hypertonicity restrict the limb functions, and Lai et al., suggested that even 6 months later after the impairment is recovered to some extent, there are still 55–80% of the patients with residual disturbances in the upper limb, which can cause the permanent functional impairment in performing the activities daily living (ADL)(12).

Stroke restricts the restoration of daily living, social participation and other ADL(13). In particular, according to Jorgensen et al. 21% of the patients with stroke died: 18% were not able to do functional walking; 11% needed assistance in walking; only the rest 50% were able to do independent walking(1). Kelly et al., reported that the patients with stroke showed slower walking than the normal population, greater energy consumption and shorter duration in walking time(14).

Walking is closely associated with trunk rotation, among which the rotational coordination between the thoracic vertebrae and pelvis is essential. In particular, the thoracic vertebrae, along with major/minor rhomboids and trapezius meddle fiber, is connected with many muscles and involved in the stability of scapula and the movements of the upper limb. The major/minor rhomboids, trapezius meddle fiber and levator scapulae work in a manner that the glenoid fossa faces toward downside by pulling the scapula inferior angle into superior medial and raising the scapula. With respect to the motility of the upper limb, especially it is reported that 2° of gleno-humeral abduction or flexion leads to 1° of the upward rotation in scapulothoracic joint, and the gleno-humeral movement occurs at 2:1 ratio compared to the scapulothoracic joint movement(16).

Although there are a variety of studies using the functional electrical stimulus (FES), proprioceptive neuromuscular facilitation (PNF) and both methods, relatively fewer studies have been conducted on the impacts of scapula adductor on the scapular movements, upper limb functions and walking in the patients with stroke.

Therefore, this study aims to the impact of the training using FES, PNF and combining both to the scapula adductor on the patients with stroke.

MATERIALS AND METHODS

Subjects

The study subjects include 15 patients admitted to Phillip Hospital located in Seoul, Korea, The subjects were diagnosed as hemiplegia due to stroke at least 6 months ago, classified as class 4 or above in the recovery period of hemiplegia according to Brunnstrom’s classification system. Only the patients with the spasticity in the scapula adductor were included. In addition, they were all scored 20 or above in the MMSE-K without any cardiovascular, internal and orthopedic disorders that may affect the treatment. Among the candidate subjects, those with the ability to walk over 10m independently were randomly selected and 5 patients were assigned to each of FES, PNF and combined group to implement the treatment program consisting of five 30-minute-long sessions per week for total 6 weeks.

Measuring Instrument

To assess the upper limb functions, total 8 movement methods were implemented as follows: shoulder flexion, shoulder abduction, bringing hand to the occipital region, touching hand to the back, grasp, pinch grasp, moving cubic object and pegboard, The total score for these 8 movements was 32. The manual function test (MFT) and the pressure detection sensor attached to the slipsole measured the pressure onto the front foot and the heel, and this walking data obtained from the patients was sent to and temporarily stored by the portable compact controller attached to the ankle. Then this data was wirelessly sent to the computer installed with the ‘Smartstep’ software which assesses the walking function.

Experiment Method

The subjects were sufficiently informed of the purpose and methodology of this study. The unnecessary behaviors that may affect this study were restricted. They were assigned to each of FES, PNF and combined group.

For the electrical stimulus in FES group, the FES device named ‘Microstim’ made by Medel GmbH in Germany. Using Valutrode(Axelgard, USA), it was attached to the origin and insertion of the rhomboideus major and minor muscles, which is a scapula adductor. Then, the indirect electrical stimulus method was adopted which stimulates the sensory receptor connected to muscle, GTO or sensory nerves. This stimulator allows the control of frequency, contraction and relaxation time and conduction time and provides the two options of the functional electrical stimulus mode for function training and the transcutaneous electrical nerve stimulus mode for pain reduction, The intensity was set as high as it can induce the muscle contraction when electricity flows