The Effects of EMG Biofeedback Training on Shoulder Pain and Muscle Tone of Upper Trapezius in Patients with Spinal Cord Injury

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Purpose The purpose of this study was to determine the extent to which EMG biofeedback training plus exercise program are associated with a reduction in the shoulder pain and the muscle tone of upper trapezius in manual wheelchair users with spinal cord injury. Methods Exercise group (N=12) was instructed to do stretching and strengthening exercise to alleviate shoulder pain for 8-week, 50 minutes/day, 5 days/week. EMG biofeedback training group (N=12) was assigned to do the same program plus EMG biofeedback training to induce muscle relaxation. The level of pain was measured by WUSPI, and Myoton®PRO was utilized to measure the changes in tone, stiffness and elasticity of the upper trapezius. Results Both of experimental and control groups were effective for shoulder pain and muscle tone. However, in comparison between groups, EMG biofeedback training group showed a statistically significant difference in reduction of the shoulder pain and in muscle stiffness as compared with exercise group (p<.05). Conclusions EMG biofeedback training when combined with exercise program appear to show positive effects in the shoulder pain reduction.

Key words Spinal cord injury, Shoulder pain, EMG biofeedback.

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I. Introduction

The primary aims of rehabilitation after spinal cord injury are to improve a physical activity level, recover various functions through using the muscles available, and to make activity daily of livings possible in sitting. The research has reported that individuals with SCI move in a wheelchair, during which they were exposed to overuse of soft tissue around the shoulder due to compensatory movements with upper arm for the stability and mobility following an incomplete innervations on trunk muscle. Most of the pain above neurologic SCI level appear due to musculoskeletal problem, which was affected by increased use of upper arm such as wheelchair transfer and wheelchair propulsion. Also, compressive stress such as weight bearing in the acute SCI phase has proven as one of the causes of the shoulder, elbow, wrist, and hand pain. Many previous studies have suggested muscle strengthening and stretching exercises, which reported that muscle imbalance and repetitive use related to self-care and wheelchair were causes of shoulder pain in the SCI patients. In addition to muscle strengthening and stretching exercises, biofeedback training have offered to control the pain due to overactive muscle. Biofeedback training is the technique of providing biological information to patients in real-time that would otherwise be unknown and it is promotes active participation and thus may motivate patients to adopt an active role in establishing and reaching goals in rehabilitation. Manual wheelchair propulsion in chronic SCI, with its highly repetitive muscle activity, puts the wheelchair users at irregular work/rest cycles, and which results in secondary pain. In this case, EMG biofeedback to improve muscle balance and relax muscle tone of the shoulder was effective in pain control, decreasing to 64% compared with pre-treatment.
Despite the strong evidence supporting the tonic changes affecting pains for manual wheelchair users with SCI, most researchers have examined the muscle strengthening and stretching for controlling pain in manual wheelchair users with SCI. Therefore, the purpose of this study was to examine the effect of EMG biofeedback training and exercise program are associated with a reduction in the shoulder pain and the muscle tone of upper trapezius.

II. Materials and Methods

1. Subjects
A total of 24 volunteered from Yeeun Hospital to participate in the study. Inclusion criteria were: 1) the individual had less than two years post SCI, 2) the individual had a spinal cord injury with C7 or lower base on classification of ASIA scale (The American Spinal Injury Association Impairment Scale), 3) the individual propelled a manual wheelchair 30 hours per week or more, 4) the individual had musculoskeletal pain in the shoulder girdle region (neck, shoulder, upper back) rated as 3 to 8 for VAS (on a scale of 0 to 10) that was evaluated during performance of daily activities, and 5) the individual was able to perform a resistance training using the upper arm. The participants were no given medication or intervention, for a particular purpose, that may affect the pain. Our study followed the principles of the Declaration of Helsinki and all patients provided informed consent.

2. Study design
This study was designed to be a randomized, prospective clinical trial, with 12 participants assigned to a exercise program for wheelchair user with shoulder pain and 12 participants assigned to the same exercise program plus EMG biofeedback. Participant were assessed at the baseline of pre-intervention and at the end of post-intervention, participated in a 8-week intervention period. Baseline and posttest data were collected by an evaluator who was blind to group assignment.

3. Outcome measure
1) WUSPI (Wheelchair User’s Shoulder Pain Index).
The Wheelchair User’s Shoulder Pain Index (WUSPI) is a self-report measure to rate shoulder pain in wheelchair users and consist of 15 different activities, including such as wheelchair mobility, transfer, and activities of daily living. The WUSPI uses 15 visual analog scales ranging from 0, no pain to 10, worst pain ever experienced, with a maximum total score of 150. We assessed with Korean-version of WUSPI, established reliability and validity.

2) Tone, stiffness, and elasticity
A hand-held myotonometer, uses painless and non-invasive means to provide quantitative and objective assessments of muscle properties. Mechanical characterization of the skeletal muscle, as measured by the myotonometer, may provide new insights into muscle function and help to diagnose the stage of pathologic processes taking place in the muscles. Myoton calculates muscle tone, which indicate the oscillation period in seconds. This myometer assess muscle elasticity which is the ability of the muscle to restore its initial shape after contraction, and also test a stiffness which reflects the resistance of the muscle to the force deforming the muscle. The testing end of the Myoton-3 was placed perpendicular to the skin surface above the muscle to be measured, a brief mechanical impulse was applied, shortly followed by a quick release to the muscle through an acceleration probe, and the damped oscillations of the muscle response were recorded by the acceleration transducer at the testing end of the device. Adequate psychometric properties for the myotonometric measurement have been presented.

4. Interventions
1) Exercise program group (EG)
Participants in this group attended 60-minute session for one-on-one instruction on an exercise program. They performed once a day, 50-minute per one session, five days a week, for eight weeks, and noted in a daily exercise log. Exercise programs consisted of both stretching and strengthening exercise. Stretching