Association between Stretching Exercise with Virtual Reality Game and Over Head Pulley of Frozen Shoulder Patients

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Abstract

Background and Objective: Frozen Shoulder (FS) or adhesive capsulitis is the most common musculoskeletal condition that causes pain and extensive restriction of joint motion. Virtual Reality (VR) provides a new option that is expected to help the rehabilitation program. The objective of the study was to compare the effect of stretching exercises with virtual reality games (VRG) and Over Head Pulley (OHP) through shoulder joint motion range (JMR) improvement and functional ability of FS.

Method: This research was conducted on July to September 2012, in Medical Rehabilitation Outpatient Unit of Dr. Soetomo General Hospital Surabaya. The samples were frozen shoulder patients. These inclusion criteria were new or old unilateral FS patients, the limitations of shoulder JMR both passive and active, with a minimum limit of 30 ° compared to normal shoulder JMR at least 2 shoulder movements, flexion and abduction between 6 weeks to 6 months, aged 35-65 years.

Result: The One-Sample Kolmogorov-Smirnov Test on the age range obained no significant differences (p = 0.418), the chi-square test on the sexes showed no significant differences (p = 1,000). The median of pleasure after treatment with the Mann-Whitney Test showed a non-significant difference (p = 0.317).

Conclusion: Stretching exercises compared with VGR exercises in FS patients provided the same benefits of stretching with the OHP on improvement.

Keywords: *Frozen Shoulder, Overhead pulley, Virtual Reality, shoulder wheels*

Background

Frozen Shoulder (FS) or adhesive capsulitis is the most common musculoskeletal condition that causes pain and extensive restriction of joint motion range (JMR) which interferes [1]. The exact pathophysiology of FS remains unknown and FS occurs mostly when the disuse factor occurs in people with stress, anxiety, and apathy accompanied by low pain thresholds. Effective standard therapy to restore JMR and eliminate the pain of FS has not been found yet. Previous studies have demonstrated 90% successful of conservative therapy with oral NSAID and rehabilitation therapy. Generally, FS therapeutic principles are medicaments (Non Steroid Anti Inflammatory Drug/NSAID, muscle relaxants, and steroid injections), modalities therapy (cold, heating, transcutaneous electrical nerve stimulation), exercise therapy (JMR exercises such as overhead pulley (OHP), shoulder wheel, finger ladder, Codman Pendular exercise), shoulder manipulation, and surgery [2].

A variety of new methods and techniques in the rehabilitation of FS have been developed such as dynamic splinting rigid or Kinesio taping. Exercises with shoulder wheels, OHP, and sticks are standard exercises for FS. Other studies have shown significant improvements in the use of pulleys with transcutaneous

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electrical nerve stimulation compared to thermal therapy modalities with therapeutic exercise and manipulation. The OHP is used as one of the standard rehabilitation therapy for stretching exercises in dealing with FS patients in sub-acute or chronic phase [1].

Virtual Reality (VR) is an interactive environment produced by computer simulations with the real world. This technology is run through an interface that has been adapted to human senses, thus making the user into the virtual world. Users can react with the virtual world through every action detected from position and movement, therefore the hardware processes changes that occur in the virtual world according to the rules created by its creators and provide feedback to its users. Initially, VR was used in students with physical disorder who were often excluded from research because of their lack ability resulting the difficulty to control themselves when in dangerous situations [3].

Thus, this new technology could provide an attitude-enhancing experience and reduce anxiety. In its development, VR was applied to various rehabilitation programs such as stroke, head trauma, autism, cerebral palsy, and rehabilitation of cognition. The VR has potential to achieve compliance required for effective rehabilitation. Side effects of VR were nausea and visual impairment, but this effect on many studies was minimum or nonexistent. The VR provides a new option to help the rehabilitation program, although it still requires further research and evaluation [4].

This study was a preliminary study to determine the effect of stretching exercises with virtual reality games (VRG) on the improvement of shoulder JMR and functional ability in FS patients, compared to stretching exercise with OHP which became standard therapy in Medical Rehabilitation, with attention to patient's pleasure. Therefore, stretching exercises with VRG can be used as a new choice therapy in the treatment of FS patients in the future.

Method

This research was an experimental research, randomized pre-post test control group design done on FS patients. This research was conducted on July to September 2012, in Outpatient Unit of Medical Rehabilitation Installation of Dr. Soetomo General Hospital Surabaya. The samples were FS patients who met the inclusion criteria and did not meet exclusion criteria. Ethical appeals were submitted to the Ethics Commission for basic science/clinical research at Dr. Soetomo Surabaya [5].

The inclusion criteria were new or old unilateral FS patients, with JMR limitation both passive and active, having minimum limit of 30 ° compared to normal shoulder JMR at least 2 shoulder movement such as flexion and abduction between 6 weeks to 6 months, aged 35-65 years, able to read the clock, could understand and follow simple verbal instructions, willing to fill out shoulder self-report form in the instrument of DASH, mild shoulder pain with VAS score 1-3, the strength of the affected side shoulder muscles: MMT ≥4, willing to stop therapy under treatment with replaced therapy available in the study, willing to participate in this study by signing an informed consent after getting an explanation [6].

The samples were randomized into 2 groups, group 1 (control) received ultrasound diathermy modal therapy on painful shoulder for 10 minutes and shoulder stretching exercise using OHP, with frequency 3-9 times a week. Group 2 (treatment) received ultrasound diathermy at shoulder pain area for 10 minutes and shoulder stretching exercises using VRG, with frequency 3-9 times a week [7].

The data were tabulated and analysed statistically using SPSS (SPSS. Inc. Chicago IL). The hypothesis test for increased shoulder JMR obtained ratio data thus independent t-test, delta, paired t-test were performed for the groups. Hypothesis test of functional ability improvement (DASH) pre and post test obtained ordinal data thus it was done Wilcoxon signed rank test [8]. The functional abilities between the treatment and control groups were performed by Wilcoxon-Mann Whitney test and the delta pre and post treatment. The pleasure level obtained ordinal data thus it was done Wilcoxon signed rank test [9].

Result

The average of shoulders JMR of flexion, extension, abduction, adduction, external rotation and internal rotation after treatment between control and treatment groups showed no significant difference ($p > 0.05$). The result of abnormal JMR delta on abduction in control group between before and after treatment was $27.5^o \pm 33.5^o$ ($p = 0{,}053$). While in treatment group was $15.0^o \pm 12.2^o$ ($p = 0.010$) (Table 1).

The result of average JMR delta on abduction between the control group and the treatment group showed a non-significant difference (p = 0.338, Table 3). While on flexion in the control group was 11.3 ± 13.6º (p = 0.051). The average delta on flexion in the treatment group was 10.0º ± 11.0º (p = 0.037). The the average delta on flexion between control group and treatment group showed significant difference (p = 0.843, Table 1).

Median pain scores before and after treatment between the control group and the treatment group showed no significant differences (p >0.05). Median pain scores before and after treatment in the control group showed no significant differences (p = 0.066). Median pain scores before and after treatment in the treatment group showed a significant difference (p = 0.034) (Table 2)

The median delta pain score in the control group was 0.5 and in the treatment group was 1.0 with p = 0.955 (Table 4). Median score of shoulder functional ability, both before and after treatment between control group and treatment group was p >0.05 (Table 2). The median delta score of functional ability in the control group was 9.05 and in the treatment group was 12.50; with the Mann-Whitney Test showed no significant difference (p = 0.792) (Table 4). The median pleasure level after treatment between control group and the treatment showed a non-significant difference (p = 0.317, Table 3).

Table 1. Comparison of Shoulder JMR Before and After Treatment

JMR	Group	Pre	Post	Changes	Comparation test
		(`x ± SD)	(`x ± SD)	(`x ± SD)	(Pre-post)
Abduction	Control	91.9o ± 21.7 o	119.4o ± 39.5 o	27.5 o ± 33.5 o	p = 0.053
	Group	90.6 o ± 31.4o	105.6 o ± 37.5 o	15.0 o ± 12.2 o	p = 0.010
	Comparation test (between groups)	p = 0.928	p = 0.487	p = 0.338	
	Control	110.6 o ± 20.6o	121.9 o ± 19.1o	11.3 o ± 13.6 o	p = 0.051
Flection	Treatment	91.9 o ± 32.4 o	101.9 o ± 36.9 o	10.0 o ± 11.0 o	p = 0.037
	comparison test (between groups)	p = 0.189	p = 0.195	p = 0.843	

Table 2. Comparison between Pain and Functional Ability (DASH) before and after group

Variable	Group	Pre (Median)	Post (Median)	Changes (delta)	Comparison(Pre-post) test
Pain (Score)	Control	3.0	2.0	-0.5	p = 0.066
	Treatment	2.0	1.5	-1.0	p = 0.034
	Comparison(between groups)	p = 0.206	p = 0.427	p = 0.955	
Shoulder Functional Ability (Score)	Control	20.45	13.60	-9.05	p = 0.018
	Treatment	23.90	14.75	-12.50	p = 0.018
	Comparison(between groups)	p = 0.673	p = 0.711	p = 0.792	

Table 3. Comparison of Pleasure Level after Treatment between Groups

Variable	Group	Score(Median)	Comparison Test
Pleasure	Control	4.0	p=0.317
	Treatment	4.0	

Discussion

Frozen shoulder often occurs on non-dominant shoulder because when the shoulder hurts, the body trying to protect by bringing the shoulder to the body and tends not to use the sick shoulder. Other studies have shown that humans who stand upright in their daily activities use supraspinatus muscles, thus gravity causes stress in capsules and tendons that retain hanging arms, and forward and sideways movements cause friction and compression resulting in rotators cuff muscle ischemia between tuberosity major and acromion. OHP has an assistive active stretching effect, indicated in FS sufferers who have subtle signs, where active practice without help is ineffective. Patients with FS who have subtle signs are patients who can not reach the ears or even the back of the head by using a sore shoulder [10].

Almost all subjects in this study were included in the subtle sign. In control group, when subjects moved the healthy shoulder and the sick shoulder was indirectly pulled by the pulley, thus he sick shoulder muscles did not work fully and there was a maximum pull. In accordance with the theory that the pain is the biggest inhibitor for a muscle movement [11]. This should be avoided, especially in the shoulder area, because its muscle activity required coordinated, stable and functional joint movement. It was proven in previous studies that there was a delay in muscle latency in the impingement subjects versus the healthy group. this was similar to a study on knee that reported an onset of vatus laterals happened before vastus medialis indicating the presence of different motor control. [12]

In addition, because the strain treatment group had to respond to the order of the VRG first, thus the stretching

time was less. Reduced time of this strain would affect the effect. Based on guidance from the American College of Sports Medicine (ACSM), stretching prescribing prescriptions had to adhere to the following guidelines, those were 3 times a week, the intensity at mild discomfort, 10-30 seconds for each stretch, and 3 to 5 repetitions for each stretch [13].

The improvement of JMR in the treatment group due to active stretching exercises was consistent with a study that reported the success of rigid shoulder therapy with active JMR practice. Other studies have shown that active JMR pendulum and exercise were better than passive stretches and manipulations that exceed the pain threshold [14].

Increased shoulder JMR and functional abilities in this study, proving that physical therapy (modalities and stretching exercises) significantly reduced pain and increased shoulder JMR in patients with FS. Thermal modality therapy as one of FS procedures before exercise was more effective to regain JMR and restore function, but stretching exercise was a major component of therapy in musculoskeletal disorders. A prospective study on the effect of shoulder stretching programs of 75 patients with stage 2 FS showed that 90% subjects had satisfactory results and only 7% required further therapy.

Previous research on healthy subjects was given a pain stimulus while playing VRG which was evaluated directly by functional Magnetic Resonance Imaging reported that there was a significant decrease in pain rate and an increase in brain oxygen activity. Possible mechanism of analgesics was through the attention diversion from pain stimuli and an increase in the pleasure level [15].

This pleasure would produce endorphins through limbic system activity. Endorphins played a role as excitation-conducting agents that activated brain analgesia system. Pain in treatment group obtained a significant decrease after treatment. Other studies found that adherence to rehabilitation therapy was associated with improved therapeutic outcomes. The VR had the potential to help achieve the adherence required to undergo an effective rehabilitation program. Given the increased motivation through the enjoyment and enthusiasm of the patient's compliance with physical rehabilitation therapy, VR provided additional useful physical therapy for patient in rehabilitation program [16].

Both groups did not get any side effects either due to modalities or stretching exercises. Exercise should be done gently and with concentration. The subjects had to understand the purpose of the exercise, thus the effort was more focused and avoided the substitution movement. Uncomfortable sensations might occur, but not to interfere, or to cause persistent pain and aggravation. Stretching exercises were performed with a 'stretched' sensation, not a pain [17].

Conclusion

It could be concluded if the stretching exercise compared to JMR exercise in FS patients, VRG provided the same benefits of stretching with the OHP on improvement. Stretching exercises with VRG provided similar benefits compared to stretching exercises with OHP on shoulder functional abilities in FS patients. Stretching exercise therapy with VRG and OHP gave the same pleasure value in FS patients. Stretching exercise therapy with VRG could reduce pain.

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