IJBPAS, August, 2012, 1(7): 982-990

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

QUADRICEPS FEMORIS STRENGTH TRAINING: EFFECT OF NEUROMUSCULAR ELECTRICAL STIMULATION VS ISOMETRIC EXERCISE IN HEALTHY YOUNG ADULTS

SHAHNAZ P*, MIRZA M, SHAHZAD N, ALAM NM, SINGH AK

Department of Physiotherapy, School of Pharmacy and Medical Sciences, Singhania University, Jhunjhunu, Rajasthan, 333515, India

***Corresponding Author: E mail: shahnazpt@gmail.com**

ABSTRACT

The aims of this study were to evaluate the effectiveness of neuromuscular Electrical stimulation with Isometric exercise on quadriceps femoris strength training in healthy young adults could increase muscle strength. Twelve females healthy young adults (n=12) in the age group of 18-28 years were randomly placed into three groups: Group A (n=4) was given Isometric strengthening exercise at 90° angle, Group B was given Neuromuscular Electrical Stimulation. Group C was given maximum voluntary isometric contraction along with Neuromuscular Electrical stimulation only 4 sessions per week for the period of 3 weeks. Muscle strength between group A, group B & group C prior to intervention was compared with post 9th day, 21st day post intervention using one way ANOVA in which increase strength is statistically non-significant ($p>0.05$) in between the groups and within the groups. No increase in muscle strength is produced after 3 weeks of training by isometric exercise at 90° angle and NMES along with MVIC and NMES alone in healthy young adults.

Keywords: Neuromuscular Electrical Stimulation, Isometric Exercise, Maximum Voluntary Isometric Contraction.

INTRODUCTION

Strength is the ability of muscle to produce force necessary to overcome a resistance in one maximal effort **[1].**

An isometric contraction is defined as a condition in which the torque due to the load in matched by a torque of equal

magnitude, but opposite direction exerted by the muscle although there is no change in whole muscle length with an isometric contraction, the muscle fiber shorten. Even during isometric contraction cross-bridges are cyclically attached, detached and reattached. Therefore movements of thick and thin filaments are resisted by neighboring sarcomeres **[2]**. The isometric exercises were popularized in 1950's by Hettinger and Muller (Enoka, 1998). They supposed that the isometric regime produced good hypertrophic responses, took little time and were convenient and economical **[3].**

Neuromuscular Electrical stimulation is another current method that has a place in the strengthening of weak muscles **[4]**. A number of physiological studies have demonstrated that muscle strengthening is strongly influenced by the tension imposed on the muscle. The influence of muscle tension on muscle strength was recently presented by Kernell et al., Currier and Mann, Selkowitz **[5]** used neuromuscular electrical stimulation to train maximum voluntary isometric contraction and observed increased in isometric quadriceps femoris force. Similarly Lai et al., **[6]** concluded that NMES training intensities of the maximum voluntary isometric contraction (MVIC) produce greater strength gain. A good number of studies advocate the use of electrical muscle stimulation as an adjunct to muscle strengthening exercises **[6, 7, 8].**

The results of this training intensity of maximum voluntary isometric contraction during neuromuscular electrical stimulation on the strength response of quadriceps femoris muscle will guide the therapist who design the treatment plan for strengthening and improve their functional outcome.

METHODS AND MATERIALS

Subjects

After Assessment, female healthy (n= 12) in the age group of 18-28 years were included if they do not have any deformity of knee, back and hip, Diabetes, history of fracture, trauma to knee joint and muscles and Participated in sports.

Study Design

The study is experimental repeated measure design to compare the effect of strength training by isometric exercise and effect of neuromuscular electrical stimulation and strength effect by maximum voluntary Isometric contraction along with neuromuscular electrical stimulation. It consist of three groups of which Group A was given Isometric strengthening exercise at 90° angle, Group B was given neuromuscular electrical stimulation, Group C was given maximum voluntary isometric contraction along with

Neuromuscular Electrical stimulation, intervention was given to all groups for 4 days in a week for 3 weeks.

The dependent variables were measured for all groups prior to intervention, after nine days and at the end of 3 weeks or 21 days by using strain gauge.

Testing Procedure

For testing of the isometric strength prior to the intervention, subjects were positioned in high sitting position with back supported and subject restrained by straps at thigh and pelvis. The outer lever arm (OLA) of quadriceps chair acted as a fixed end with the strain gauge attached to it and other end of strain gauge were fixed to a fixed rod at the back of the chair. The subject were instructed to exert force as hard as possible for 3 sec, 3 trials were taken at an interval of 10 sec, high stable force were taken and noted for analysis. The therapist provided a strong verbal encouragement in order to motivate the subject to attain maximum voluntary effort during isometric testing.

Strength Training Procedure

Group A: Isometric strengthening exercise at 90° angle: Subject were seated on a quadriceps chair with their back supported and leg maintaining at 90° angle. Afterwards the subject were instructed to do maximum voluntary isometric contraction against the heavy object, exercise instructed for 10 repetition 4 session/ week for the period of 3 weeks holding time 10 second and relaxation time 20 second.

Group B: Neuromuscular Electrical stimulation application:

A neuromuscular electrical stimulator (Enraf Noinus Endomed 982 Reg. No.: 12287), provided for muscle stimulation. The stimulator produced a frequency of 2500 Hz delivered with AMF 50 HZ with 5 sec, time interval and holding time 8 sec, ramp up and down 2 sec and intensity was set according to the subject's tolerance and it was given for 25 minutes. The subject were seated on a treatment coach with their back supported. A Pair of standard carbon rubber electrodes in moistened sponge pads was positioned over the femoral nerve in the femoral triangle and transversely over the quadriceps muscle motor point. Motor points were identified as the area, which produced greatest visible muscle contraction when electrical stimulation intensity was applied. The electrodes were securely fastened using Velcro straps **[8]**. Total treatment time was 25 minutes.

Group C: Neuromuscular electrical stimulation application along with maximum voluntary isometric contraction:

Similar parameter of NMES as described in group B were given to the subject along with maximum voluntary Isometric

contraction. Subjects were instructed to isometrically contract the quadriceps muscle while they are receiving the current. Subject received verbal encouragement to do maximum isometric contraction at 90° angles against the heavy object. Subjects were seated on the high treatment couch back supported and leg maintains at 90° angles. Total treatment time 25 min.

Statistical Analysis

Statistical analysis was done using SPSS – 11 versions. One way ANOVA test was used to compare the value of isometric quadriceps strength of Group A, Group B, Group C, and also within a group between pretest, post 9th day, and post 21st day. The significant of p value is less than 0.05 (p>0.05).

RESULTS

Twelve subjects (n=12) mean age of 20.66±2.6 healthy volunteered were included in this study. Four subjects were placed in each group A & groups B and group C. All the subjects completed the study 4 days in a week for 3 weeks. Isometric strength were measured by using strain gauge on each, subject over the 3 week course of study on pre test, post 9th day and post 21st day.

Within group A, at 90° of knee flexion isometric strength training , the average mean for isometric strength pre test was 27.08 and on second observation on 9th day, mean muscle strength was 29.49 which show slight improvement of 2.41 and post 21st days reaching to 29.91 with total improvement in strength was 2.83. Its 'F' value is 0.26 and 'p' value is 0.7 which shows nonsignificant (p>0.05).

Within Group B, application of NMES at the quadriceps femoris muscle, The average mean for isometric strength measurement pre test was 24.33, and muscle strength after second observation, 9th day was 25.66, which shows slight improvement of 1.33 ,and post 21st day, third reading was 25.91 which shows a sight strength gain improvement was 1.58. Its 'F' value is 0.034 and 'p' value is 0.96 which statistically nonsignificant (p>0.05).

Within group C, using NMES along with MVIC the mean muscle strength in the pre test was 23.0, after 9th day second observation was 23.66 which show the strength difference of 0.66 and post 21st day, third reading was 23.99 which show strength improvement of 0.99 in between pre and post intervention. Its 'F' value is 0.08 and 'p' value is 0.92 which is insignificant (p> 0.05).

Muscle strength between group A, group B & group C prior to intervention was compared using one way ANOVA whose mean value of group A is 27.08, in group B is 24.33 and in group C is 23.00. The

mean difference between the groups A & B was 2.75, group A & group C was 4.08. Its 'F' value is 0.339 and p value is 0.727 which is statistically nonsignificant (p> 0.05).

Similarly in post 9th day muscle strength compared between group A., B and C. The mean value of group A is 29.49 and group B is 25.66 and group C is 23.66 so the mean difference between the group A and B was 3.83, the mean difference between group A and Group C was 5.83. Its 'F' Value is 0.862 and its 'p' value is 0.45 which is not significant.

Muscle strength between group A, group B & group C, 21st day post intervention whose mean value of group A is 29.91, group B is 25.91 and group C is 23.99, the mean difference between group A and group B is 4.0 and between group A and C is 5.92. Its 'F' value is 0.92 and p' value is 0.43 which is statistically nonsignificant ('p'>0.05).

Table 1: Comparison of MVIC Between Pre Test, Post 9th day and 21st day

Group	Pre Test	Post 9th day	Post 21st day	F value	P value
A	27.08□6.2	29.49□5.8	29.91□5.5	0.269	0.77
B	24.33□10.3	25.66□8.6	25.91□8.5	0.034	0.96
C	23.00□3.36	23.66□3.6	23.99□3.7	0.08	0.924

Table 2: Comparison MVIC Between Group A, Group B and Group C

Test Day	Group A	Group B	Group C	F value	P Value
Pre test	27.08□6.2	24.33□10.2	23.00□3.36	0.33	0.727
Post 9th	29.49□5.8	25.66□8.6	23.66□3.6	0.862	0.454
Post 21st	29.91□5.5	25.91□8.5	23.99□3.7	0.926	0.431

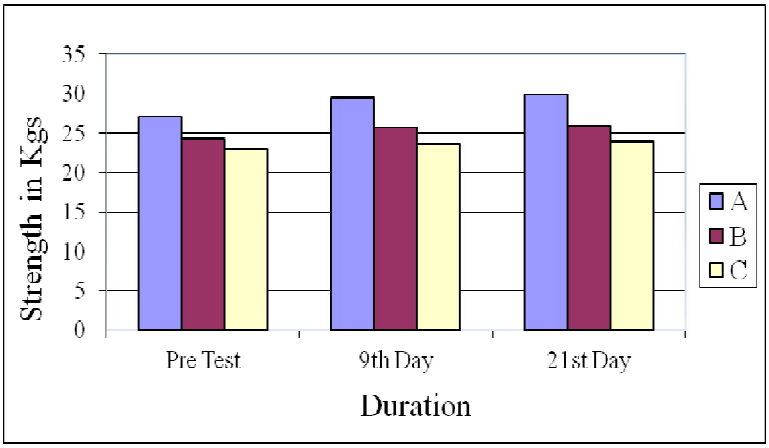

Figure 3: Comparison of Changes in Mean Muscle Strength Between Groups A, B & C

DISCUSSION

The primary goal of this study was to test the hypothesis that NMES along with MVIC application to quadriceps femoris muscle in healthy individual would increase the strength response.

Overall results of this study indicate that NMES, Isometric strength training at 90^{o} angle and NMES along with MVIC application to quadriceps femoris muscle in healthy individual result strength improvement but it is not statistically significant between each group in 3 weeks training session.

Our inability to show strength gain with NMES and NMES along with MVIC and isometric strength training at 90° applied 4 times per week for 3 week may have been due to small number of healthy subjects, thus it shows null hypothesis .

As there is no strength gain difference in any group after application of NMES vs Isometric exercise. The subjects in group C and B may experience more fatigue response due to NMES along with MVIC so there is no strength gain. The concept of a weekend quadriceps femoris being fatigue resistant was reported by **Snyder Mackler *et al*., [9]** and assumes that weakened quadriceps femories muscle have selective type IIb fiber atrophy which reduces the decline of force during muscular work**. Parker *et al*., [10]** observed a similar reduction in quadriceps femoris force decline with a decreased availability of type II fiber area for work immediately following increasing amounts of NMES, thus the type IIb fibers in the quadriceps femoris of group 3 may have been selectively fatigued by training which could account for the fatigue resistance or lack of force decline.

Several investigators have examined strength response to electrical stimulation

and reported increased strength of skeletal muscle, Improve muscular contraction among patient after knee surgery and increased muscles girth [**11**]. Few studies shows using electrical stimulation in repeated sessions have not supported the increased muscular strength **[12, 13].** The D.P Currier Ralph Mann **[14]** investigated the effects of electrical stimulation and its comparison with training mode MVIC and NMES and NMES +MVIC who trained their dominant leg, three times a week for five weeks. Analysis revealed that there were no statistically significant differences in strength among the groups as a result of training. In addition no significant changes between pretest and post tests results were found for any of the other three rates of contraction. In 1979, Currier and Coworkers reported that a program of Electrical Stimulation combined with static exercise at MVC was no more effective (21%) than was a traditional regimen of maximum effort isometric exercise (19%).

Hettinger and Muller reported that Isometric exercise produced increased muscular strength **[15] Lindh *et al*.,** reported that isometric training effects were specific to the joint angle at which training is performed. Differences in joint angles at which Isometric training took place in a shorten position (knee flexion angle of 30°), or a mid range position (knee flexion angle of 60°) or a Lengthened position (Knee at 90° angle of flexion).

Result of this study have no significant differences using these three modes for strength training but as investigated by different researcher's indicate that isometric strength training at lengthened position increase muscle strength and have a good psychological effect in which patient cannot safely perform exercise.

CONCLUSION

Results of this study support the following conditions and conclude this study: No increase in muscle strength is produced after 3 weeks of training by isometric exercise at 90° angle and NMES along with MVIC and NMES alone in healthy subjects. Hence in conclusion, the null hypothesis, that electrical stimulation and isometric exercises at 90° knee flexion of quadriceps femoris muscle and NMES along with MVIC is more effective in improving muscle strength is rejected.

ACKNOWLEDGEMENT

We express our heartfelt gratitude and indebtedness to **Dr. R. M. Panday,** HOD Department of Biostatistics, AIIMS for devising the study design and making sure that all tables and graphs were accurate and appropriately organized, so that explanation could be clear and more easily understood.

REFERENCE

[1] American physical therapy associations: guide to physical therapist practice: Physical Therapy, 77, 1997, 1163.

[2] Lindh M, Increase of muscle strength from isometric quadriceps exercises at different knee angles, Scand J. Rahob. Med., 11, 1979, 33-36.

[3] Gardner G, Specificity of strength changes of the exercised and non exercised limb following isometric training, Research Quarterly, 34, 1963, 98-101.

[4] Curries DP and Mann R, Muscular strength development by electrical stimulation in healthy individuals, Physical Therapy, 63, 1983, 6.

[5] Mackler LS, and Delitto A, Use of electrical stimulation to enhance recovery of quadriceps femories muscle force production in patient following anterior cruciate ligament reconstruction. Physical Therapy, 74 (10), 1994, 901-907.

[6] Kim AW and Rosen AM, selective muscle activation following electrical stimulation of the human, knee joint, Archives of Physical Medicine Rehabilitation, 76, 1995, 750-757.

[7] Mackler LS, Elecrical stimulation of the thigh muscles after reconstruction of the anterior cruciate ligament, The Journal of bone and joint surgery, 73-A7: 1025-1035.

[8] Hartsell HB and Kramer JF, A comparison of the electrode placement muscle tension and isometric torque of the knee extensors, JOSPT, 15, 1992, 168-171.

[9] Synder Mackler L, Binder Macleod SA and William PR, Fatigability of human quadriceps femoris muscle following anterior cruciate ligament reconstruction Med. Sci. Sports Exercise., 25, 1993, 783-789.

[10] Parker MG, Berhold M, Brown R, Hunter S, Smith MR and Ruhlling RO, Fatigue response in human quadriceps femoris muscle during high frequency electrical stimulation, J. Orthop Sports Physical Ther., 7, 1986, 145-153.

[11] Ericksson E, Sports injuries of the knee ligaments: their diagbnosis, treatment, rehabilitation and prevention Med Sci. Sports, 8, 1976, 133-144.

[12] Currier DP and Mann R, Muscular Strength development by Electrical Stimulation in healthy individual.

[13] Hettunger T, Muller EA, cited by: Hislop HJ, 1963, Quantitative changes in human muscular strength during

isometric Exercise, J. Amer Phys. Ther. Association, 43, 1963, 21-23.

[14] Massey BH, Nelson RC and Sharkey BC, Effects of high frequency electrical stimulation on the size and strength of skeletal muscle, J Sports Med Phys Fitness, 5, 1965, 136-144.

[15] Johnson DH, Thurston P and Ashcroft PJ, The Russian technique of Faradism in the treatment of chondromalacia patellae, Physiotherapy Canada, 29, 1977, 266-268.