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EFFECTIVENESS OF RUSSIAN ELECTRICAL STIMULATION AND STRENGTHENING EXERCISES IN PATELLOFEMORAL PAIN SYNDROME

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ABSTRACT:

Background: Patellofemoral Pain Syndrome (PFPS) refers to the clinical presentation of anterior knee pain related to changes in the Patellofemoral joint. Reports of Patellofemoral pain incidence in the clinical environment range from 21% to 40%. It affects as much as 25% of the general non-athletic population and occurs in all age groups and more common among adolescents and young adults. Good clinical results have been shown with quadriceps strengthening, with both open and closed kinetic chain exercises. Also Electrical stimulation is used extensively in physical therapy, and “Russian currents” have been advocated for use in increasing muscle force.

Objective: To compare the efficacy of Russian electrical stimulation and Strengthening exercises on pain, disability and VMO strength in PFPS.

Study Design: Randomized Control Trial

Materials & Method:30 subjects both male and female, Age group of 18-45 years with PFPS were recruited for study. Strength, Pain and Disability were analyzed in RES and ST groups.

Outcome measures were NPRS for pain, 1RM for strength and KPS for disability.

Results: Results showed that there is significant improvement Post- RES and ST in both groups.

Conclusion: Russian stimulation and Strengthening Exercises were proved to be both effective tool in reducing pain, disability and improving strength of VMO in PFPS patients. Russian stimulation revealed more significant effect in reducing pain and improving VMO strength and strengthening exercises improved the functional outcome of the patients.

Keywords: Patello-femoral Pain Syndrome (PFPS), Vastus Medialis Oblique (VMO), Russian Electrical Stimulation (RES), Strength Training/ Strengthening Exercises (ST /SE).

INTRODUCTION

Patellofemoral pain syndrome (PFPS), clinical presentation of anterior knee pain is related to changes in the Patellofemoral joint[28,14]presenting a difficult problem for surgeons, therapists, and patients alike. Most studies describe symptoms of insidious onset, such as diffuse peri-patellar and retro patellar localized pain in one or both knees that is aggravated by walking uphill or downhill, squatting, kneeling, or by prolonged sitting with flexed knees.[1]

Of the several cited theories for PFPS, dysfunction of the extensor mechanism is commonly accepted. Knee extensor strength deficit are common clinical finding in patients with PFPS.[22,23,16] Attempts have been made to correct extensor dysfunctions such as quadriceps weakness by various methods of exercising. The vastusmedialis oblique (VMO) has an important role as a medial stabilizer of the patella and assists in the normal functioning of the Patellofemoral joint.[13,17,28] If the VMO atrophies, it is believed that greater lateral deviation of the patella will occur, thus contributing to be a normal Patellofemoral joint stress and, ultimately, PFPS[10,11,12]. Following this line of reason, rehabilitation specialists and researchers have advocated selective strengthening of the VMO to help restore normal Patellofemoral biomechanics and reduce pain.[2,12,27]

Jonsonn et al[21] done the study that aimed to include 20 patients in each group, but was stopped at the half time control because of poor results achieved in the concentric group. He concluded that eccentric, but not concentric, quadriceps training on a decline board, seems to reduce pain in jumper's knee. Jessica[15] et al did a study on 18 subjects and found that squatting exercise significantly preferentially activates VMO. Therefore, the recommendation is that this exercise is a suitable treatment for readdressing the mediolateral imbalance at the PFJ,a proposed cause of PFPS.Witvrouw et al[10] , on the basis of the results, the authors conclude that both open kinetic chain and closed kinetic chain programs lead to an equal long-term good functional outcome.

Rehabilitation specialists have expressed interest in the application of electrical current to the musculoskeletal system. As a result, there has been a proliferation of electrical devices for which claims of favorable results have been made. A controversy exists, however, as to whether electrical stimulation alone is of strengthening normal skeletal muscle.

Selkowitz[24] has reviewed the experimental evidence in the English-language literature for increasing muscle force by use of Russian electrical stimulation. He concluded that there is convincing evidence for increased muscle force, but little evidence that the force gains were greater than those produced by voluntary exercise or a combination of exercise and electrical stimulation. Delittoet al[6] compared force gains produced by Russian electrical stimulation (RES) with gains produced using voluntary exercise following anterior cruciate ligament surgery. The electrically stimulated group showed higher force gains than the group that received voluntary exercise.

Electrical stimulation is used extensively in physical therapy, and “Russian currents” have been advocated for use in increasing muscle force.[24,26] Russian currents are alternating currents (AC) at a frequency of 2.5 kHz that are burst modulated at a frequency of 50 Hz with a 50% duty cycle. The stimulus is applied for a 10 second “on” period followed by a 50-second “off” or rest period, with a recommended treatment time of 10 minutes per stimulation session.[24] This stimulation regimen (called the “10/50/10” regimen), applied once daily over a period of weeks, has been claimed to result in force gains, but many of the claims appear to be anecdotal.[18]

Methods:

Selection Criteria

The sample consisted of 30 subjects, 11men and 19 women, with no history of musculoskeletal disease; age ranged from 18 to 45 years, with a mean of 28.3 and 28.06 years. Each subject was randomly assigned to one of two independent groups: a strength training group and Russian electrical stimulation group.

Outcomes

Outcomes of interest were VMO strength, as expressed by 1RM, disability as expressed by a score on a clinically reproducible functional test -KPS, and pain as quantified by a NPR.

Instrumentation

The output of the Russian stimulator as monitored on screen consisted of a medium frequency sinusoidal alternating current with a frequency of 2,500 Hz burst at 50 Hz (10ms ON : 10ms OFF) at a maximum tolerable level to stimulate muscle tissue (1000Hz or 1kHz was more effective for nerve trunk stimulation), stimulating for a 10 second duration. Using 2500Hz stimulation at 10milliseconds means that the effective muscle stimulation is at 50Hz. The stimulator was designed to deliver 10 seconds of stimulation followed by a 50-second rest period and again 10 seconds of stimulation (10/50/10 regimen).

Procedure :

Exercise Group-Participants warmed up prior to testing by cycling for 5 minutes on a stationary bicycle. After a 1 minute rest period, participants were familiarized with each of the Weight cuffs by performing 8-10 repetitions of a light load (~50% of predicted 1RM). Exercises performed were Straight leg raises, Unilateral Step up and Step down, Short arc leg extension and Double leg squat. After a 1 minute of rest, participants performed a load (~80% of estimated 1RM) through the full range of motion. After each successful performance, the weight increased until a failed attempt occurred. One minute rests were given between each attempt and the 1- RM was attained within 5 attempts and 5 minutes rest separated each test. The strengthening protocol aimed for exercises consisting of 3 sets of 10 repetitions. Testing of 1RM is done by Matt Brzycki equation Patients were instructed to stop any prescribed exercise if pain intensity exceeded 5 on a 0-10 numerical pain rating scale, (0 = 'no pain' and 10 = 'severe pain') and to adjust training loads accordingly (weight cuffs) All exercises should be progressed gradually.

RES Group- Subjects received hot pack for 15 minutes followed by RES at a frequency of 2500Hz (2.5 kHz) to stimulate muscle tissue (1000Hz or 1kHz was more effective for nerve trunk stimulation), stimulating for a 10 second duration. Using 2500Hz stimulation at 10milliseconds means that the effective muscle stimulation is at 50Hz. The continuous vs burst protocols were evaluated (i.e. continuous 2500Hz or 2500Hz burst at 10ms intervals .The recommended stimulation should be applied with a 2500Hz carrier medium frequency sinusoidal alternating current, burst at 50 Hz (10ms ON : 10ms OFF) at a maximum tolerable level. To check the accuracy of the electrode placements and patient tolerance of electrical stimulation output was carefully increased using the constant stimulation option. The quality and specificity of the VM muscle contraction confirmed the appropriateness of the electrode placement and the patient tolerated the current comfortably. The constant stimulation option was turned off and the stored program implemented. A palpable supero-medial patellar movement occurred while the stimulator cycled on. The placements of the electrodes were marked with an indelible pen. The Gel pads were changed daily. Patient was also advised that if the stimulation became uncomfortable or the skin became irritated to contact us immediately. The subjects tolerated progressively increasing amounts of current intensity during the study. No one in this group complained of patellofemoral joint discomfort during or after their daily sessions. No subject described the current as painful, but most subjects preferred to adapt to the current's "pins and needles" sensation by increasing the daily treatment intensities gradually.

After completion of the 6 week program, both the groups were assessed again with NPRS scale for pain, KPS for disability and 1RM for VMO strength.

Analysis:

Mean and standard deviation were used as descriptive statistics. In addition to the weekly means being calculated, the initial and final values of the variables for each individual were plotted in graphs. Unpaired sample t-test was applied between the groups to find out the difference in Pain and Strength. Non-Parametric test (Mann-Whitney U test) was applied between the groups to find out difference in Disability. Level of significance was set as 5 per cent (<0.05)

Main Findings

According to Table 1, statistically significant differences were observed for the values of the difference between pain before and after the treatment programs. ($p>0.05$). However, no significant difference ($p<0.05$) was observed in the analysis of pain between both treatment programs.

Table 1: Mean, Standard deviation, t value and p value of NPRS within and between Group A and Group B

Group A	Mean±S.D	t-value	p <0.05
Pre NPRS	6.02±1.08	16.32	Significant (0.002)
Post NPRS	3.06±0.79		
Group B	Mean±S.D	t-value	p <0.05
Pre NPRS	5.60±0.98	12.47	Significant (0.001)
Post NPRS	3.33±1.04		

Table 2 demonstrates that changes occurred in the values of KujalaPatellofemoral score before and after treatment. But between treatment effect was less significant thus revealing both treatment to be equally effective tools.

Table 2: Median, Range, Minimum, Maximum and IQR value of KPS within and between group A and group B

Group A	Median±Range	Median		IQR
		Min.	Max.	
Pre KPS	68.0±3.61	65.0	71.0	6
Post KPS	72.0±3.81	71.0	77.0	6
Group B	Median±Range	Median		IQR
		Min.	Max.	
Pre KPS	70.0±3.92	66.0	73.0	7
Post KPS	72.0±2.90	70	76	6

Results in table 3 concludes changes in VMO strength after the treatment program

Table 3: Mean, Standard deviation, t value and p value of 1RM within Group A and Group B

Group A	Mean±S.D	t-value	p <0.05
Pre 1RM	2.05 ±0.49	26.56	Significant(0.037)
Post 1RM	8.25±1.07		
Group B	Mean±S.D	t-value	p <0.05
Pre 1RM	2.11±0.35	52.09	Significant (0.004)
Post 1RM	8.28±0.63		

Discussion:

The Strength gain, relief In Pain and improved functional impairment after Strength training and RES in the present study is supported by many other studies that have reported similar conclusions using a variety of Electrical Stimulation program and added value of selective VMO Strength training in improving pain and function in PFPS.[7,8,9,4,11,20]A number of studies have examined the relationship between pain, VMO strength and function in PFPS. Thus various methods of treatment exist with own claims of success without any attempts of comparing the maximal effective methods.

The present study showed an effect of RES in improving strength of VMO which was consistent with the findings of Delitto et al (1989)[5] who did the study with the stimulation and made significant strength improvements over and above those obtained from training alone. The RES was compared with voluntary exercise programs, and significantly higher force gains were made with the RES.

Various other stimulation modalities were compared to rule out the maximal effective methods by Snyder- Various other stimulation modalities were compared to rule out the maximal effective methods by Snyder-

Mackleret al[25]. He compared RES with Interferential Therapy (IFT) and an NMES (muscle stimulation) protocol. The IFT resulted in significantly less muscle force generation in response to the stimulation. The highest average force results were obtained with RES, but these were not significantly different from those obtained from the NMES stimulation. Finally in this study the results (gain in strength) obtained with the RES group were significantly better than those undertaking exercise.

Curwin et al[3] reported that clinical use of an electrical stimulator, which claims to duplicate the Russian current format, has not demonstrated results similar to those reported by Kots in either abnormal or normal muscle. Thus results of this study contradict with the present study.

In the present study, in the group receiving RES and ST, analysis of Pain relief, Disabilty and Strength improvement was done by NPRS, KPS and 1RM respectively by statistical mean. The result of the study suggests that RES and ST provide greater effect in reduction of pain, disability and improved VMO strength in people with PFPS.

So this study adds that RES and ST given for PFPS patients gives good relief and improves the condition. The benefits of these programs are reduced when it is stopped, however when it is continued for long duration, the treatment effects are maintained.

Various interventions are done to reduce pain, improve function and improve strength. VastusMedialis Oblique strength deficit is common clinical finding in patients with PFPS. The first limitation of the study being that the study lacks a control group. It also lacks large sample size. No follow up was done to determine whether improvement in VMO strength and function were maintained over time. Further research is needed using large sample size and a control group in order to increase the external validity. Long term follow up can be done to examine the effect of maintenance of treatment.

Conclusion:

Combination of various physical treatment have been done before for improving VMO strength, reducing pain and physical function But till date few researches has been done to determine the efficacy of Russian Electrical Stimulation and Strength Training on pain, muscle strength and disability in patients with PFPS. Therefore, this research would come out with more appropriate and acceptable treatment protocol for patients and therapists.

In the both treated groups there was significant reduction in pain, improvement in muscle strength and disability after RES and Strengthening exercises.. But, there was no significant difference in pain reduction, improvement of strength and physical function between RES and ST group. So it is concluded that both are effective in reducing pain, improving strength and physical function in individuals with PFPS following 6 weeks of treatment.

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