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Original Research Article

Short-Term and Long-Term Effects of Interferential Therapy and Russian Current on Pain and Quadriceps Muscle Strength in Post Operative Lower Limb Fractures

Sreeraj Rajan[1], Sarabjeet Singh Kohli[2], Sahil Bhaisaheb[3]

[1]Professor, MGM College of Physiotherapy, Kamothe, Navi Mumbai, India.
[2]Professor, Department of Orthopaedics, MGM Medical College, Kamothe, Navi Mumbai, India.
[3]Intern, MGM College of Physiotherapy, Kamothe, Navi Mumbai- 410209, India.

Corresponding Author: Sahil Bhaisaheb

ABSTRACT

Background: Lower limb fractures contribute to the functional impairments and death in people. Decreased Quadriceps muscle strength is a common clinical observation in patients with lower limb injury or because of immobilisation. Interferential Therapy (IFT) and Russian Current (RC) are two medium frequency alternating currents with frequencies of 4kHz and 2.5kHz respectively. The purpose of this study is to find the short term and long-term effects of IFT and RC on Quadriceps muscle strength in patients recovering from post-operative cases of lower limb fractures.
Methodology: 38 participants between age group 16-70 years were selected according to inclusion and exclusion criteria and divided into 3 groups, Group A(n=14) received Interferential Therapy and Conventional Exercises(CE); Group B(n=13) received Russian Current and CE and Group C(n=11) received only CE for 14 days. Patients were given electrical treatment for 6 days and were assessed pre- intervention, 6th day after intervention and the 14th day after intervention. The outcome measures were Numerical Pain Rating Scale (NPRS), Range of Motion and Isometric muscle strength.
Result: For within group analysis the Friedman Test and for between group analysis the Kruskal Wallis Test was used. The intra group comparison was statistically significant with p=< 0.05 while the between group comparison was not statistically significant with p=>0.05.
Conclusion: RC and IFT were not superior to conventional treatment alone.

Keywords: Interferential Therapy, Russian Current, Electrical stimulation, Quadriceps muscle strength.

INTRODUCTION

Lower limb fractures are the main cause of disability and functional impairments in sufferers. Mobility limitations are very common and can be partially related to the lack of strength and muscle power. The fractured leg can be 20% weaker than the non-fractured leg post operatively between 3 to 36 months. [1] Due to trauma, there is decreased Quadriceps muscle strength and increased hamstring to quadriceps ratio on the injured limb as compared to the non-injured limb. [2] Quadriceps muscle wasting is a prevalent clinical observation in patients with a lower limb disease, fracture, injury, or because of immobilisation. One theory is that pain causes reflex inhibition of the quadriceps, which in time induces an atrophic response within the muscle with subsequent loss of

muscle size which will cause activity limitations and inferior quality of life in recovering patients. [3,4] As quadriceps femoris strengthening and prevention of disused atrophy is important in recovering patients from a lower limb fracture a lot of research is going on in this field.

Stimulation of the body's natural physiological healing processes with physical methods of treatment is an old therapeutic principle. [5] Interferential Therapy (IFT) and Russian Current(RC) are two medium frequency alternating currents with frequencies of 4kHz and 2.5kHz respectively. The basic principle of IFT is to use the significant physiological effects of low frequency electrical stimulation by interfering two medium frequency currents without the associated painful and unpleasant side effects associated with low frequency stimulation. [6,7] RC, again a medium frequency current is a type of electrical stimulation which is delivered in a pulsed (or burst or interrupted) output. The pulses or bursts are delivered at a 'low' frequency and is used to mainly generate a motor response but it also has been investigated as an electro-analgesia type intervention. [8]

There are studies available on Traditional Low Frequency electrical stimulations, Interferential Current Therapy and Russian Current stimulation and its effects on pain, muscle strength and function with mixed results. [4,9-16] But there are not enough studies done on comparing IFT and Russian currents as muscle strength gainers in real-time clinical scenario. So, the purpose of this study is to find the short term and long-term effects of Interferential Current Therapy and Russian Current on pain and quadriceps muscle strength in patients recovering from post-operative cases of lower limb fractures.

METHODOLOGY

Patients who underwent a surgery after a lower limb fracture in MGM Medical College Hospital, Navi Mumbai were selected from the day of operation. They were divided into three groups (Group A, B and C). Patients with age group between 16-70 years, with lower limb fractures less than 2 weeks old and who had undergone internal fixation after a lower limb fracture were included in this study. Patients who were mentally retarded, unconscious, who had altered sensation, epilepsy, cardiac patients, with diabetes mellitus, infections, chronic smokers or with tobacco intake in any form, compound fractures, polytrauma and patients who did not give consent for the study were excluded. Ethical approval was obtained from institutional ethical committee prior to the study.

38 Subjects in total, were divided into 3 groups. Group 1 (n=14) received Interferential Therapy with a beat frequency of 50Hz, Sweep 50Hz with intensity tolerable to the patient for 10 minutes [7,9,17] and conventional physiotherapy. Group 2 (n=13) received Russian Current with 10:50:10 protocol [4] and conventional physiotherapy. Group 3 (n=11) which was a control group received only conventional physiotherapy. Electrodes were placed 3 inches above the patella over the muscle bulk and the electrodes used were carbon rubber electrodes with a size enough to cover the Quadriceps muscle group transversely (Figure 1). The interventions were given for 6 days. All patients were assessed using a Numerical Pain Rating Scale (NPRS) for Pain at rest and on activity. Quadriceps muscle strength assessment was done by using a BP apparatus. The cuff of the BP apparatus was inflated to 20 mm/Hg as base pressure and placed under the knee (Figure 2) and the patient performed isometric contraction of the quadriceps for 5-8 seconds [18] to put pressure on the cuff (Figure 3). The change caused in the analogue meter was noted. The same measurements were repeated on the 6th day post intervention (post 1) and 14thday post interventions (Post 2) when they were called for follow up. Subjects were in continuation of conventional exercise post discharge till 14th day follow up. The collected data was compared,

coded, tabulated and analyzed. Conventional Exercises included Ankle Toe Movements (ATM), Static Hamstrings, Static Quadriceps, Dynamic Quadriceps in Sitting, Stretching of the Tendoachilles and Hamstrings, Heel Slides, Thomas Stretch of the involved hip, Straight Leg Raises. [19,20] All subjects were in routine rehabilitation protocol which included conventional exercises.

RESULTS

Prior to the analysis the data were subjected to descriptive statistics which showed that the subjects taken were in the Mean Age of 34.08 with a Standard Deviation (SD) of 14.08 and a Male to Female Ratio of 18:1. Out of 38 patients 5were dropped out as 1 of them developed infection and 4 did not turn up for follow up assessment.

When the data were subjected to the Shapiro-Wilk normality test, it showed a not normal distribution. So, the rest of the statistical analysis was done by non-parametric tests. For within group analysis, the Friedman test was used. The result for Pain on rest (p=.007) and activity (p=<.001) in Group 1 that received IFT showed significant difference from Pre-Post 1-Post 2 intervention in that order. There is significant difference (p=<.001) in muscle power improvement in the same group. The result for Pain on rest (p=.010) and activity (p=<.001) in Group 2 that received RC showed significant difference from Pre-Post 1-Post 2 intervention in that order. There is significant difference (p=<.001) in muscle power improvement in the same group. The result for Pain on rest (p=.061) showed no significant difference in Group 3 that received conventional exercise but pain on activity showed significant difference (p=<.001) from Pre-Post 1-Post 2 intervention in that order. There is significant difference (p=<.001) in muscle power improvement in the same group.

For between group analysis, the Kruskal Wallis test was performed which revealed no significance between the groups (Table 1). A comparison of mean values shows that IFT with a mean value of 0 at the 1st post intervention level showed a better performance than RC and CE with mean values 0.2 and 0.22 respectively for the short-term effect in pain at rest. For the long-term effect of pain at rest, IFT and RC with mean values at the 2nd post intervention level being 0 and 0 respectively equally performed better than CE with a mean value of 0.11 (Figure 4). A comparison of mean values revealed that RC with a mean value of 3 at the 1st post intervention level showed a better performance than IFT and CE with mean values 3.6 and 3 respectively for the short-term effect in pain on activity. For the long-term effect of pain on activity, IFT with a mean value of 1.8 at the 2nd post intervention level showed a better performance than RC and CE with mean values 1.7 and 1.4 respectively (Figure 5). A comparison of mean values revealed that RC with a mean value of 37.6 at the 1st post intervention level showed a better performance than IFT and CE with mean values 30.5 and 29.1 respectively for the short-term effect in muscle power again. For the long-term effect of muscle power gain, CE with a mean value of 38.3 at the 2nd post intervention level showed a better performance than IFT and RC with mean values 39.3 and 42.8 respectively (Figure 6).

Figure 1: Electrode placement covering Quadriceps Muscle.

Figure 2: Sphygmomanometer under the knee joint for pressure feedback to assess the strength of the Quadriceps Muscle. The analogue meter shows a reading at a relaxed state.

Figure 3: Sphygmomanometer under the knee joint for pressure feedback to assess the strength of the Quadriceps Muscle. The analogue meter shows a reading at a contracted state.

Table 1: Kruskal-Wallis test for between group analysis.

Test Statistics					
	Pain_Rest_pre	Pain_Rest_post1	Pain_Rest_post2	Pain_Activity_pre	Pain_Activity_post1
Chi-Square	.139	1.658	2.667	.616	3.032
Df	2	2	2	2	2
Asymp. Sig.	.933	.436	.264	.735	.220

Test Statistics				
	Pain_Activity_post2	Muscle_pre	Muscle_post1	Muscle_post2
Chi-Square	.769	3.229	2.649	.530
Df	2	2	2	2
Asymp. Sig.	.681	.199	.266	.767

The Kruskal-Wallis test shows no significance at p=> 0.05.

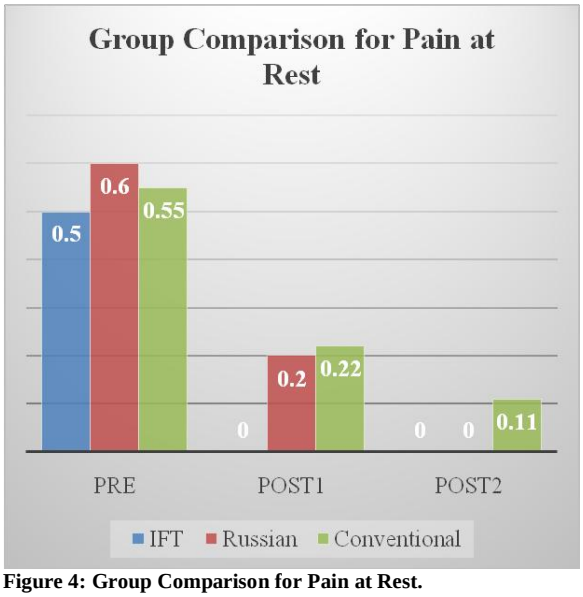

Figure 4: Group Comparison for Pain at Rest.
IFT: Interferential Therapy. Russian: Russian Current. Conventional: Conventional Exercise. Pre: Pre-treatment; Post 1: 6th day after treatment; Post 2: 14th day after treatment.

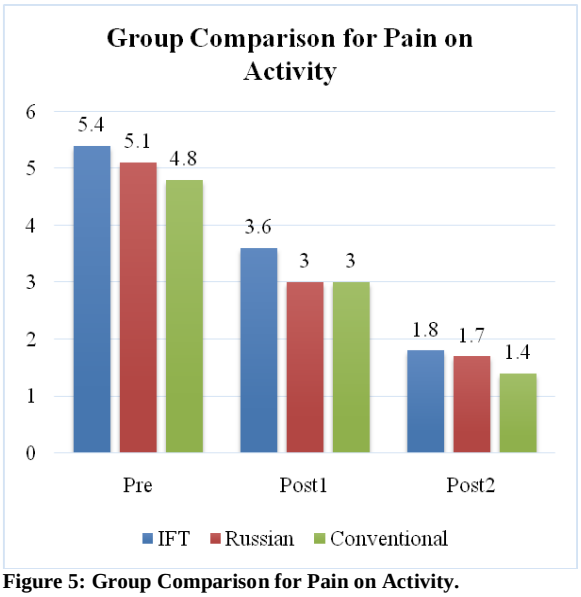

Figure 5: Group Comparison for Pain on Activity.
IFT: Interferential Therapy. Russian: Russian Current. Conventional: Conventional Exercise. Pre: Pre-treatment; Post 1: 6th day after treatment; Post 2: 14th day after treatment.

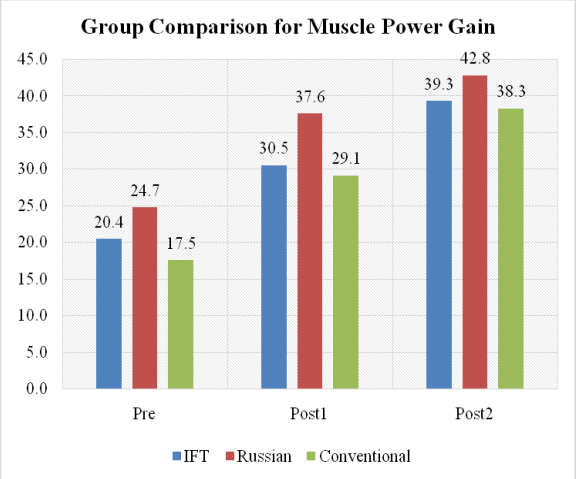

Figure 6: Group Comparison for Muscle Power Gain.
IFT: Interferential Therapy. Russian: Russian Current. Conventional: Conventional Exercise. Pre: Pre-treatment; Post 1: 6th day after treatment; Post 2: 14th day after treatment.

DISCUSSION

This study results shows that all the three interventions were effective in reducing pain and improving muscle power in the test subjects. The result of this study goes in sync with the results by Hingane N et al [21] who studied the effects of Russian currents and to compare strength training modes on improving Quadriceps muscle strength and width in asymptomatic young adults which included 3 groups namely: Russian currents only, Exercise only, and combination of both which showed that there was a statistically significant difference in the ultra-sonographic width and isometric strength of quadriceps femoris muscle measured bilaterally in all the three experimental groups but there was no statistical difference between the three groups in increasing the strength of Quadriceps muscle bilaterally. In a study performed by Avila MA et al [22] to assess the effects of neuromuscular electrical stimulation (NMES) associated with an isokinetic training program in healthy young men and women, one limb underwent only the isokinetic strength training while the other underwent the same training but with NMES associated with each contraction. The results showed that the association between NMES and isokinetic concentric voluntary strength training did not improve the strength gains and neuromuscular properties of voluntary strength training itself for healthy young participants of both genders. Walmsley RP et al [23] compared Torque Generated by Knee Extension with a Maximal Voluntary Muscle Contraction after Electrical Stimulation in subjects who underwent Maximum voluntary contraction, Low frequency current stimulation; Medium frequency current stimulation showed that no method was superior to maximal voluntary contraction.

When a muscle contracts due to electrical stimulation the changes taking place within the muscle are like those analogous with voluntary contraction. The increase in local circulation which may be produced by the local pumping effect of the stimulated muscle or the effect of autonomic nerves and therefore blood vessels may help remove chemicals from the area which are stimulating nociceptors thereby reducing pain. [24]

In a steady or repetitive voluntary contraction, it is the slow twitch, highly fatigue resistant muscle fibres which are recruited first. They produce a much lower peak force with a longer duration. Fast twitch muscle fibres produce high peak forces of short duration and they are recruited last and are energy inefficient. They get recruited first in the electrical stimulation of the muscle and a limited number of motor units are firing at a relatively higher frequency. The recruitment of fast-fatigue fibres produces very large increases in muscle force but the force cannot be sustained. Fatigue is unlikely to occur with voluntary contractions but is likely to occur at frequencies used in transcutaneous stimulation as there is a higher frequency of activation. Energy efficient, fatigue resistant motor units are recruited first and fast twitch fast-fatigue fibres are kept in reserve to produce shorter duration, high forces. In an electrically induced contraction, there is a disproportionate recruitment of large diameter fast-fatigue fibres and a rapid rate of fatigue. [25-27]

So, it is recommended that Electrical Stimulations like Interferential Therapy and Russian Current can be used with regular physiotherapy as it has a short-term effect on pain relief as well as improving muscle power.

CONCLUSION

According to this study, Russian Current is marginally better than Interferential Therapy and Conventional Exercise in decreasing pain and increasing muscle strength in the short-term effect and Conventional Exercise sustained the pain relief and muscle strength for a longer duration that is for the long-term effect. But statistically, none is better than the other in decreasing pain and increasing muscle strength.

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