

RESEARCH ARTICLE

ULTRASOUND, INTERFERENCE CURRENT, AND EXERCISE FOR RECURRENT KNEE PAIN DUE TO OSTEOARTHRITIS

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Abstract

Introduction:- To study the effectiveness of ultrasound, interference current, and exercise in recurrent knee pain due to osteoarthritis and to find the optimal frequency, intensity, and duration of exercise.

Materials and methods:- Twelve outpatients (age 67.16 ± 7.89 years) with recurrent knee pain due to osteoarthritis were followed for one month. They were treated with interference current, ultrasound, and exercise for two weeks. All patients were instructed to perform the exercises as often as possible, for as long as possible, and as intensively as possible at home for one month. The pain was reported on a visual analog scale daily for two weeks and after one month. In the beginning, in the middle, and at the end of the month were recorded knee mobility, the periarticular muscle strength, frequency, intensity, and duration of the exercises.

Results:- During the two-week course the pain was decreasing every following day (P>0.05). Over the weekend the pain increased (P<0.05). After two weeks and after one month improved the pain (P<0.05), knee mobility (P>0.05), and muscle strength (P>0.05). There was a significant correlation and regression between pain and exercise frequency (P<0.05). If the exercise frequency is greater than five times a day, the pain regressively tends to zero (P>0.05). There was no correlation between pain and exercise intensity (P>0.05) and between pain and exercise duration (P>0.05).

Discussion:- The pain decrease during the week and its increase during the weekend show that interference current, ultrasound, and exercise have a short-term analgesic effect. Improving all parameters after two weeks and after one month shows that exercise has a long-term effect. Frequent, short, and low-intensity exercise is recommended due to the correlation with regression between pain and exercise frequency, in the absence of a correlation between pain and intensity or duration of exercise. The recommended frequency of exercise is five times a day, as at this frequency the pain tends to disappear.

Conclusion:- The combination of ultrasound, interference current, and exercise is effective in recurrent knee pain due to osteoarthritis. Short and low-intensity exercises with a frequency of more than five times a day are optimal.

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Introduction:-

Osteoarthritis of the knee is one of the most common causes of pain and disability [1-3]. Half of all people over the age of 65 have osteoarthritis changes in the knee joints detected by imaging diagnostics [2, 3].

Osteoarthritis of the knee is often treated with exercise and physical factors [1-8]. It is assumed that exercises have both short-term and long-term symptomatic (analgesic) effects and pathogenetic effects (improve muscle imbalance, joint stability, and flexibility) [1,9-13]. Strengthening exercises for elongated and weak dynamic muscles are assumed to correct the muscle imbalance and increase joint stability [1,9,10,12]. Relaxing exercises for shortened and spastic static muscles are assumed to correct the muscle imbalance and increase joint stability [1,9,10,12]. Relaxing exercises for shortened and spastic static muscles are assumed to correct the muscle imbalance and increase joint mobility [1,14]. There is a principal consensus on the effect of the exercises, but their optimal frequency, duration, and intensity are unknown [1].

It is assumed that interference current has a short-term electro-analgesic effect in osteoarthritis of the knee [1,4,15-18]. Several electro-analgetic theories are suggested: at the central level - the gate theory [1,19,20], at the peripheral level – a theory of increasing beta-endorphins [1,5,7], at the receptor level – hyperpolarization theory [1,5,7] and at the microcirculatory level - metabolic theory [1,5,7].

It is assumed that ultrasound has a short-term analgesic effect in osteoarthritis of the knee due to its primary mechanical action and secondary thermal effect, which does not burden the thermoregulation, respiratory and cardiovascular systems [1,2,4,7,21,22]. Heat is formed endogenously by the transformation of oscillating mechanical ultrasonic energy into thermal energy due to the increased vibration of molecules [1,7,21].

There are no studies in the literature on the combined effect of interference current, ultrasound, and exercise. There is no consensus about the optimal frequency, duration, and intensity of exercise. The aim was to study the effectiveness of the combination of interference current, ultrasound, and exercise in the rehabilitation of recurrent knee pain due to osteoarthritis and to find the optimal frequency, intensity, and duration of exercise.

Material And Methods:-

Twelve outpatients (age 67.16 ± 7.89 years) with recurrent knee pain due to osteoarthritis (mean pain duration 8.33 ± 4.27 years and last exacerbation 2.9 ± 1.91 weeks before study enrollment) were followed for one month. They were treated for two weeks with interference current, ultrasound, and exercise.

Ultrasound was applied by a direct labile method to the knee. An indifferent contact gel was used in order for the ultrasound to penetrate the tissues. The ultrasound head was moving in smooth circular motions on the surface. The intensity of the ultrasound was 0.4 W/cm^2 . The duration of the procedure was 6 minutes. [1,22,23].

Interference current was applied by a four-electrode stable method. The electrodes were fixed transversely above and below the knee so that the lines of force of the two current circuits intersected in the knee. A rhythmic change of frequencies of 90-100 Hz was used, without a vector. The duration of the procedure was 10 minutes [1,4,15-18].

Exercises were performed under the supervision of a rehabilitator once a day for 10 minutes. It began with the relaxation of the shortened and hypertonic static muscles (m.rectus femoris, m.biceps femoris, m.semitendinosus, m.semimembranosus, and m.gastrocnemius) by post isometric relaxation [24] and stretch [14]. It ended with the strengthening of the elongated and weakened dynamic muscles (mm.vasti) [25]. Patients were instructed to perform the learned exercises as often as possible, as long as possible, and as intensively as possible at home for one month.

The pain was reported on a visual analog scale daily for two weeks and after one month [26]. The mobility of the knee joints, the strength of the surrounding muscles, the frequency, intensity, and duration of the exercises were registered in the beginning, in the middle, and at the end of the month. The mobility of the knee joints was measured by goniometry [1,27]. To calculate total knee mobility in percentages, angular degrees were transformed into percentages of normal mobility, with percentages in knee flexion and extension averaged. The strength of the surrounding muscles was measured with manual muscle testing [1,27]. To calculate the total strength of the surrounding muscles in percentages, the degrees of manual muscle testing were transformed into percentages of normal strength, with the percentages of the flexors and extensors of the knee joint averaged.

Analysis of variances (ANOVA) with Bonferroni's multiple post hoc tests and Pearson's correlation with post hoc multiple correlation tests were used for statistical processing of the results.

Results:-

During the two-week course, pain significantly decreased with each following day (P<0.05). Over the weekend, the pain increased (P<0.05). After two weeks and after one month, the pain significantly decreased (P<0.05) (**Figure 1**).



Figure 1:- The pain intensity reported daily for two weeks and after one month by a visual analog scale (VAS in cm.). The sixth and seventh days are a weekend.

The mobility in the knee joint and the muscular strength of the periarticular muscles increased at the end of the twoweek therapeutic course compared to the beginning (P<0.05) and after one month versus after two weeks (P<0.05).

There was no correlation between pain and age (P>0.05), between pain and exercise intensity (P>0.05), and between pain and exercise duration (P>0.05). There was a significant correlation and regression between pain and muscle strength (P<0.05), between pain and joint mobility (P<0.05), and between joint mobility and muscle strength (P<0.05). The three-dimensional multiple regression relationship between pain, joint mobility, and muscle strength (P<0.05) is presented in **Figure 2**.



Figure 2:- Three-dimensional regression relationship between pain (VAS in cm.), joint mobility (in % of the norm), and periarticular muscle strength (in % of the norm).

Correlation analysis found an inverse relationship between pain and exercise frequency (P<0.05). Regression analysis found that the intensity of pain decreased statistically significantly with increasing of exercise frequency (P<0.05) according to the following formula:

Pain intensity (VAS cm.) = 5.09 - (0.981 * daily frequency of exercises)

According to this regression formula, at exercise frequency greater than five times daily the pain showed a regressive tendency to disappear (P <0.05), while at exercise frequency less than once a day, the pain showed a progressive tendency to increase over 5 cm. (VAS) (P<0.05) (**Figure 3**).



Figure 3:- Regression analysis between pain (VAS in cm.) and exercise frequency.

Discussion:-

The results supported the assumption that interference current, ultrasound, and exercise have a short-term symptomatic effect [2-5,7,8,21,28], because, after two weeks of physiotherapy, the knee pain decreased. In addition, our results showed that pain decreased significantly not only after a two-weeks but also every following day during a combined therapeutic course with interference current, ultrasound, and exercise. In addition, the pain increase over the weekend proved the short-term symptomatic effect of interference current and ultrasound, as their cessation in two days led to a return of pain.

The results supported the assumption that exercise has short-term and long-term symptomatic and pathogenetic effects [9-13], as after one month of exercise, knee pain, mobility, and muscle strength improved. It was found that only the frequency of exercise had a significant therapeutic effect, as only it correlated with pain, while the intensity and duration of exercise did not correlate with the pain. Regression analysis found that with an exercise frequency of more than five times a day, the pain showed a progressive tendency to disappear. Therefore, short-term and low-intensity exercises with a frequency of more than five times a day are optimal. Increasing the intensity and duration of exercise could not reduce pain, but may increase the risk of injury.

The lack of a significant correlation between pain and age, with increasing degenerative changes with age, means that there was no relationship between the degree of degenerative changes and the degree of pain. In patients with significant degenerative changes, the pain had a lower intensity compared to minor image changes and vice versa. The significant correlation between pain and joint mobility means that the pain caused a muscle guard with shortening and hypertonicity of the static muscles that restricted mobility, and vice versa. The significant correlation between pain inhibited the strength of dynamic muscles, leading to reduced muscle strength, hypotrophy, and atrophy, as well as vice versa. Electroanalgesia with interference current and ultrasound contributed to the cessation of this vicious cycle. The muscle imbalance reduced the strength of the dynamic muscles, and shortened the static muscles, leading to an increase of pain with a decrease in joint stability and mobility. Therefore, exercises aimed at correcting muscle imbalance, increasing joint stability, and mobility, are advisable.

Conclusion:-

The combination of interference current, ultrasound, and exercise is effective in recurrent knee pain due to osteoarthritis. Interference current, ultrasound, and exercise proved to have a short-term symptomatic (analgesic) effect. Exercises proved to have short-term and long-term symptomatic and pathogenetic effects, including pain

relief, improved muscle balance, increased joint mobility and stability. Strengthening exercises for elongated and weak dynamic muscles proved to correct the muscle imbalance and increase joint stability. Relaxing exercises for shortened and spastic static muscles proved to correct the muscle imbalance and increase joint mobility. Short-term and low-intensity exercises with a frequency of more than five times a day are optimal.

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