Доклади на Българската академия на науките
Comptes rendus de l'Académie bulgare des Sciences
Tome 75, No 2, 2022

MEDICINE
Clinical medicine

UPGRADING AND PROPHYLACTIC EFFECT OF EXERCISE IN SHOULDER PERIARTHRITIS

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Received on July 15, 2019
Presented by B. Petrunov, Member of BAS, on November 26, 2019

Abstract

There is a consensus about the benefit of exercise in shoulder periarthritis. However, there is uncertainty about the optimal combination of physical factors, the upgrading effect of exercise over physiotherapy and about the exercise parameters, such as frequency, intensity and duration. The aim of this study is to assess the upgrading effect of exercise. A two-week effect between two combinations of physical factors without exercise was compared versus the same double combinations of physical factors with exercise. To estimate the better combination between these two double physical factors, their two-week effect was compared. To evaluate the prophylactic effect of the frequency, the intensity and the duration of the home-prescribed exercise, these parameters were analysed after six months in all patients. Forty-eight outpatients (age 56.2±15.69 years) with shoulder periarthritis (pain initiation 3.39±3.15 months before recruitment) were treated for two weeks and followed up six months later. They were divided into four treatment groups of 12 patients. The first group was treated with magnetic field and electrophoresis with lidocaine. The second group received the same combination and exercise. The third group was treated with interferential current and laser. The fourth group received the same combination and exercise. The pain was recorded before and after the daily procedures by visual-analogue scale. Before and after the two-week treatment course, shoulder range of motion and manual muscle testing were performed. After the treatment course, each patient was instructed to perform home-exercises. After six months follow-up the frequency, the intensity and the duration of the pain were recorded, as well as the frequency, the intensity

DOI:10.7546/CRABS.2022.02.12

and the duration of the home-exercises. ANOVA, correlation and regression analysis were applied in the statistical analysis. After the treatment course in all patients there was significant improvement regarding pain ($P < 0.05$), muscle strength ($P < 0.05$) and shoulder mobility ($P < 0.05$). The most significant results were recorded in the combination of interferential current, laser and exercises ($P < 0.05$); followed by the combination of interferential current and laser ($P < 0.05$); followed by the combination of electrophoresis, magneto-therapy and exercises ($P < 0.05$); and finally by the combination of electrophoresis and magneto-therapy ($P < 0.05$). There was an upgrading effect of exercise over physiotherapy ($P > 0.05$). There was a correlation between pain frequency and home-exercise frequency ($P < 0.05$). The pain frequency tended to zero at more than five times daily home-exercises ($P < 0.05$). Over the two-week therapeutic course the lowest pain and the highest mobility and strength showed the combination of interferential current, laser and exercises; followed by the combination of interferential current and laser; followed by the combination of electrophoresis, magneto-therapy and exercises; and finally the combination of electrophoresis and magneto-therapy. There was an upgrading effect of exercise over physiotherapy. Only the frequency of the exercise had a prophylactic effect. The incidence of pain tended to zero at exercise frequency over five times daily.

Key words: shoulder periarthritis, treatment, prophylaxis, physical factors, exercise

Introduction. Shoulder periarthritis is one of the most common causes of pain in the shoulder joint [1–3]. It affects women more often than men, the dominant hand – more often than the non-dominant, and physical workers – more often than intellectual ones with the peak morbidity around the middle age [1–3].

It leads to disturbed kinetics of the entire shoulder complex [1,4,5]. The pain blocks motion in the gleno-humeral joint by defensive muscle guard [1]. This leads to scapular dyskinesis [1]. Normally, the initiation of the shoulder elevation begins after 90° gleno-humeral abduction [1]. One third of the abduction is at the expense of the shoulder belt and two thirds at the expense of the gleno-humeral joint [1]. In shoulder periarthritis the initiation of the shoulder elevation begins before the initiation of the abduction in the gleno-humeral joint and the ratio is reversed [1]. Scapular dyskinesis increases the risk of future shoulder pain by 43% [4].

Shoulder periarthritis causes pathological muscle imbalance and contractures [1]. In the transversal plane, the shortened internal rotators versus the elongated external rotators lead to internal-rotator contracture [1]. In the sagittal plane, the shortened flexors versus the elongated extensors lead to flexion contracture [1]. In the frontal plane the shortened adductors versus the elongated abductors lead to adductor contracture [1]. Therefore, the shortened muscles should be relaxed, whereas the elongated antagonists should be strengthened [1].

The most common treatment is conservative with non-steroidal anti-inflammatory drugs (NSAIDs) as well as physical medicine and rehabilitation, including

electro-analgesia with low- or medium-frequency currents, frequency currents, ultrasound, magneto-therapy, laser therapy, cryotherapy, etc. [1–3, 7]. Conservative therapy only achieves symptomatic effect [2]. In contrast, exercises have an additional pathogenetic effect on the joint function [1–3, 7].

There is no consensus about the optimal combinations of physical factors and the additional upgrading effect of exercises [1–3, 7, 8]. The first aim of the study was to compare a two-week physiotherapeutic effect between two double combinations of physical factors without exercises versus the same combinations with exercises. While there is a principle consensus about the prophylactic effect of the exercises, there is uncertainty about their individual parameters – frequency, intensity and duration [9–11]. The second aim of the study was to compare the six-month prophylactic effect between the frequency, the intensity and the duration of home-exercises in the same patients.

Hypothesis.

1. The effect of a two-week treatment course between the combination of magnetic field and electrophoresis with lidocaine is equal to the effect of the combination of interferential current and laser.

2. Exercises have an additional upgrading effect over these two combinations of double physical factors during a two-week treatment course.

3. As the frequency of the exercises increases, so does the prophylactic six-month effect.

4. As the duration of the exercises increases, so does the prophylactic six-month effect.

5. As the intensity of the exercises increases, so does the prophylactic six-month effect.

Material and methods. Forty-eight outpatients (age 56.2 ± 15.69 years) with shoulder periarthritis participated in the study. The mean initiation of the shoulder pain was 3.39 ± 3.15 months before the recruitment. They were divided into four treatment groups of 12 patients. All patients were treated for two weeks and followed up six months after that.

The first group was treated with one-procedure daily electrophoresis with lidocaine incorporated trans-dermal (transversally) with one active electrode (anode) over the painful shoulder area and one indifferent electrode (cathode) without medication over the non-painful shoulder area by galvanic current for 10 min, followed by one-procedure daily magnetic field of 0.3 T with frequency of 100 Hz over the shoulder for 15 min.

The second group was treated with the same procedures of electrophoresis and magneto-therapy used in the first group, followed by 10 min supervised exercises,

which included muscle imbalance correction by 5 post-isometric muscle relaxations of the shortened muscles (m. biceps brachii, m. pectoralis, m. levator scapulae and m. trapecius descendens), followed by 5 isometric muscle contractions of the flabby muscles (m. triceps brachii, m. deltoideus, m. supraspinatus, m. subscapularis, m. infraspinatus, m. trapecius ascendens, m. rhomboidei and m. teres minor) [1].

The third group was treated with one procedure daily interferential current using 4-electrode technique with frequency of 100 Hz for 10 min surrounding the shoulder, followed by one procedure daily He-Ne laser with wavelength of 632.8 nm, frequency of 900 Hz and total energy 2.592 J for the entire procedure of 10 min over the shoulder.

The fourth group was treated with the same procedures of interferential current and laser, used in the third group, followed by the same exercises, used in the second group.

The pain was recorded daily before and after the procedures by visual-analogue scale. At the beginning and at the end of the two-week treatment course, goniometric shoulder range of motion and shoulder manual muscle testing was performed. After the treatment course, each patient was trained and instructed to perform home-exercises, similar to those learned and performed daily during the supervised two-week physiotherapy course, as often as possible, for as long as possible, and as intensively as possible. After six months, the frequency, intensity and duration of pain, as well as the frequency, intensity and duration of the exercises, were recorded. ANOVA and correlation analysis were used for the statistical analysis.

Short-term (two-weekly) results. In all patients the pain decreased significantly after the fourth day ($P < 0.05$) and continued to decrease until the end of the two-week physiotherapy course ($P < 0.05$) (Fig. 1).

In all groups the pain decreased significantly after the two-week physiotherapy course ($P < 0.05$). The highest pain suppression showed the combination

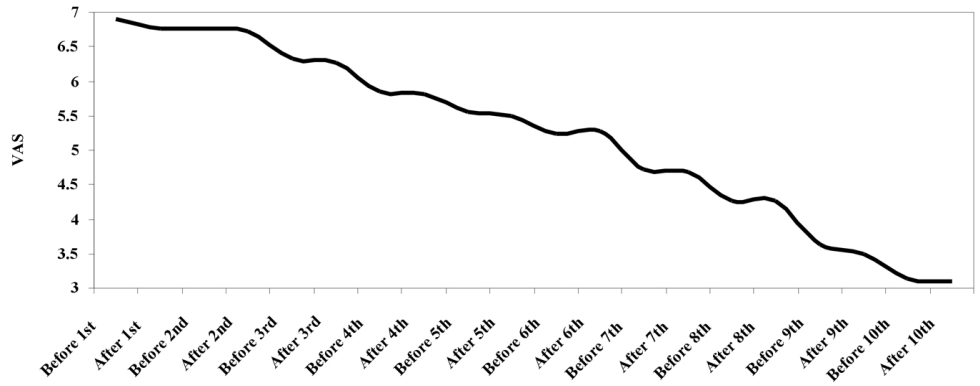

Fig. 1. Pain assessed by visual-analogue scale (VAS) before and after the daily procedures during the two-week treatment course consisting of 10 interventions

of interferential current + laser+exercises ($P < 0.05$); lower – the combination of interferential current + laser ($P < 0.05$), even lower – the combination of electrophoresis + magneto-therapy + exercises ($P < 0.05$); and the lowest – the combination of electrophoresis + magneto-therapy ($P < 0.05$). An additional upgrading effect of exercises was established over the corresponding physical factors ($P < 0.05$) (Fig. 2).

In all groups the shoulder mobility increased significantly after the two-week physiotherapy course ($P < 0.05$). The highest mobility after the two-week treatment course showed the combination of interferential current + laser + exercises ($P < 0.05$). Lesser mobility after the two-week treatment course showed the combination of interferential current + laser ($P < 0.05$). Even lesser mobility after the two-week treatment course showed the combination of electrophoresis + magneto-therapy + exercises ($P < 0.05$). The lowest mobility after the two-week treatment course showed the combination of electrophoresis + magneto-therapy ($P < 0.05$). An additional upgrading effect of exercises was established over the physical factors ($P < 0.05$) (Fig. 3).

In all groups the shoulder muscle strength increased significantly after the two-week physiotherapy course ($P < 0.05$). The highest muscle strength after

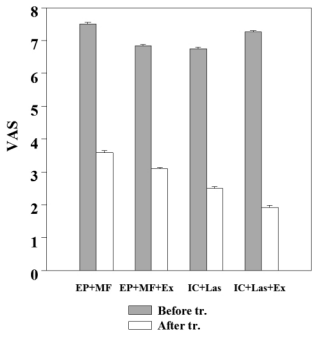

Fig. 2

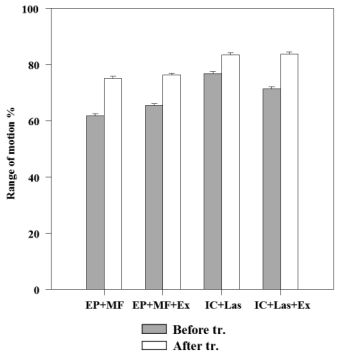

Fig. 3

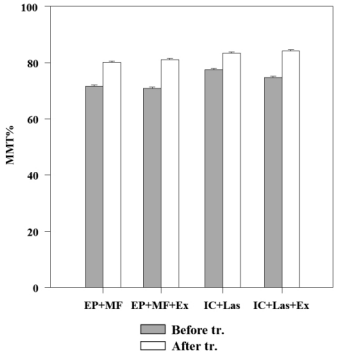

Fig. 4

Fig. 2. Pain assessed by visual-analogue scale (VAS) before the two-week treatment course (Before tr.) and after that (After tr.) for each group: electrophoresis+magnetic field (EP+MF); electrophoresis+magnetic field+exercises (EP+MF+Ex); interferential current+laser (IC+Las); interferential current + laser + exercises (IT + Las + Ex)

Fig. 3. Shoulder range of motion in percentage of the norm ("Range of motion %") before the two-week treatment course (Before tr.) and after that (After tr.) for each group: electrophoresis + magnetic field (EP + MF); electrophoresis + magnetic field + exercises (EP + MF + Ex); interferential current + laser (IC + Las); interferential current + laser + exercises (IT + Las + Ex). All ranges of motion merged by normalization as a percentage of the norm ("Range of motion %")

Fig. 4. Muscular strength ("MMT%") before and after the two-week treatment course for each group – electrophoresis + magnetic field (EP + MF); electrophoresis + magnetic field + exercises (EP + MF + Ex); interferential current + laser (IC + Las); interferential current + laser + exercises (IT + Las + Ex). The manual muscle tests were merged by normalization as a percentage of the norm ("MMT%")

the two-week treatment course was reported in the combination of interferential current + laser + exercises ($P < 0.05$); lesser – in the combination of interferential current + laser ($P < 0.05$); even lesser – in the combination of electrophoresis + magneto-therapy + exercises ($P < 0.05$); and the lowest – in the combination of electrophoresis + magneto-therapy ($P < 0.05$). An additional upgrading effect of exercises was established over the physical factors ($P < 0.05$) (Fig. 4).

Long-term (six-monthly) results. There was a correlation between the pain and the muscle strength ($P < 0.05$) as well as between the pain and the shoulder mobility ($P < 0.05$). The only correlation between the three pain parameters versus the three exercise parameters was significant between the pain frequency and the exercise frequency ($P < 0.05$). The regression analysis found that the frequency of pain was determined by the frequency of exercise ($P < 0.05$) by the following regression formula:

$$\text{Pain frequency} = 1.05 - (0.0279 * \text{exercise frequency}).$$

The following six prognostic mathematical models of this real regression formula were calculated:

1. The probability of pain occurrence after 6 months at exercise frequency 5 times a week (once daily) is equal to 0.9105 ($P < 0.05$).

2. The probability of pain occurrence after 6 months at exercise frequency 10 times a week (2 times daily) is equal to 0.771 ($P < 0.05$).

3. The probability of pain occurrence after 6 months at exercise frequency 20 times a week (3 times daily) is equal to 0.492 ($P < 0.05$).

4. The probability of pain occurrence after 6 months at exercise frequency 30 times a week (4 times a day) is equal to 0.213 ($P < 0.05$).

5. The probability of pain occurrence after 6 months at exercise frequency 35 times a week (5 times daily) is equal to 0.0735 ($P < 0.05$).

6. The probability of pain occurrence after 6 months at exercise frequency 37 times a week (> 5 times daily) is equal to 0.0177 ($P < 0.05$).

Discussion. 1. The first hypothesis was not confirmed in this study: the effect of the combination of interferential current + laser exceeded that of the combination of electrophoresis + magneto-therapy. The analgesic effect of the interferential current, the galvanic current used for electrophoresis and the magnetic field could be a result of central-level inhibition according to the Gate theory [1, 12]. The theory of the hyperpolarisation of semi permeable membrane receptors with inhibition of the triggering pain threshold is hypothesized at a peripheral level [1, 12].

According to the metabolic theory, the locally accelerated substance-P is eliminated as a result of the revulsion effect, and the pain is additionally suppressed by the stimulation of beta-endorphin production [1,12]. The pain-relieving effect of laser therapy is probably due to its inhibitory effect on pro-inflammatory cytokines and stimulation effect on anti-inflammatory growth factors [13]. Laser therapy has an equal analgesic effect to corticosteroids, exceeding the analgesic effect of ultrasound or cryotherapy, but lacking an additional upgrading effect with exercises [3,7,14,15]. The combined effect of laser therapy with other physical factors is better than the mono-modal effect according to some authors [3,16], whereas other authors [17] have suggested otherwise.

2. The second hypothesis was confirmed in this study: each group with a double combination of physical factors+exercises showed a better effect over the physical factors without exercises. Exercise therapy should be the first-line treatment to improve pain, function and range of motion [1,18]. Exercise is widely regarded as an effective intervention but prescription practice is diverse and the crucial components of exercise programmes are not fully understood [19,20]. After two weeks of rehabilitation including exercises, the muscle strength and the shoulder mobility increased significantly according to the results in our study. This confirms the consensus that exercises have an additional pathogenetic effect on the joint function [1–3,7,8,16]. In our study the groups treated by physiotherapy without exercises showed increased muscle strength and shoulder mobility as well. This could be explained by the higher pain suppression in the groups with exercises, which was supported by the significant correlation between the pain and the muscle strength as well as between the pain and the shoulder mobility.

3. The hypothesis that the frequency of the exercises has a prophylactic effect was confirmed by the correlation and the regression analysis in this study. The prophylactic effect was guaranteed at an exercise frequency over five times a day.

4. The hypothesis that the duration of the exercises has a prophylactic effect was not confirmed in this study as there was no correlation between the pain and the duration of the exercises. Therefore, it is better to exercise for shorter time but more frequently.

5. The hypothesis that the intensity of the exercises has a prophylactic effect was not confirmed in this study as there was no correlation between the pain and the exercise intensity. Therefore, it is better to exercise less intensively but more frequently.

Conclusion. For the two-week physiotherapy, all four combinations were effective in shoulder periarthritis. The most optimal combination consisted of interferential current + laser + exercises, followed by interferential + laser, followed by electrophoresis + magneto-therapy + exercises, and finally by electrophoresis + magneto-therapy. After two weeks of physiotherapy, the muscle strength and the shoulder mobility increased significantly. Pain decreased significantly not only after the two-week treatment course, but even after the fourth day. The intensity

and the duration of the exercises did not have a six-month prophylactic effect. Only the frequency of exercise had a significant six-month prophylactic effect in shoulder periarthritis. At less than five times a day home-exercise frequency, the prophylactic effect is doubtful, while at a higher frequency it is guaranteed. Therefore, it is better to exercise for shorter time with minimal intensity and more frequently than five times daily in the prophylaxis of shoulder periarthritis.

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