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# Evaluation of the Effectiveness and Efficiency of Extracorporeal Shock Wave Combined with Rehabilitation Training in the Treatment of Muscle Articulation Chronic Pain

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**Abstract:** *Objective:* To analyze the effect of combined extracorporeal shock wave and rehabilitation training treatment in patients with muscle articulation chronic pain (MACP). *Methods:* Ninety-seven MACP patients admitted to our hospital from September 2021 to September 2023 were randomly selected and were divided into Group A (control group, 46 cases, rehabilitation training treatment) and Group B (observation group, 51 cases, extracorporeal shock wave with rehabilitation training treatment), and outcomes of the two groups were compared. *Results:* The treatment efficiency, post-treatment clinical indexes (upper and lower limb function scores, activities of daily living (ADL) scores, visual analog scale (VAS) scores), and short-form 36 (SF-36) scores of Group B were better than those of Group A ($P < 0.05$). *Conclusion:* Combined extracorporeal shock wave and rehabilitation training treatment for MACP patients improved their limb function, daily activities, quality of life, and reduced pain.

**Keywords:** Extracorporeal shock wave; Rehabilitation training; Musculoskeletal joint; Chronic pain; Treatment effect

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## 1. Introduction

The number of patients with musculoskeletal chronic pain (MACP) is very high and is manifested as pain sensation lasting for more than 1 month. This leads to pathological changes from the periphery of the organism to the central nervous system. The related limb function is also affected to a certain degree, which seriously damages the physical and mental health of patients and may lead to a complete loss of the ability to perform daily activities [1]. Frozen shoulder, lumbar muscle strain, and other diseases are the main causes of chronic pain without a cure. Hence, there is an urgent need to explore ways to effectively treat MACP to reduce the patient's pain, improve limb function, and enhance their quality of life [2]. Currently, there are many ways to treat MACP, such as drug therapy, physiotherapy, surgery, and functional training. Among them, surgery can cause serious damage and is hence not generally chosen to treat MACP, whereas the conservative treatment method is preferred [3]. Rehabilitation training is a comprehensive therapy commonly used to treat MACP, which can help patients effectively improve limb function and reduce pain. However, with the prolongation of the treatment time, the enthusiasm of the patients to participate in the rehabilitation training therapy is significantly reduced, and it is difficult to obtain the desired long-term therapeutic effect. With the continuous optimization and wide application of minimally invasive techniques and equipment, more MACP patients choose extracorporeal shockwave therapy. This method uses shockwave stimulation of affected muscle, bone, and joint areas, and showed remarkable improvement [4]. The advantages of extracorporeal shock wave therapy for MACP include simple operation and rapid reduction of pain. This study analyzes the effect of combined extracorporeal shock wave and rehabilitation training treatment for MACP patients.

## 2. Information and methods

### 2.1. General information

Ninety-seven cases of MACP patients admitted to our hospital from September 2021 to September 2023 were selected and randomly grouped into two groups, Group A (control group, 46 cases) and Group B (observation group, 51 cases). Group A consisted of 26 males and 20 females aged 25–72 years old, with an average age of 53.68 ± 5.21 years. The patients weighed 45.86–87.85 kg, with an average weight of 64.85 ± 6.17 kg. The duration of disease ranged from 1–8 years, with an average duration of 2.54 ± 0.62 years. There were 19 cases of upper limb pain and 27 cases of lower limb pain. Group B consisted of 29 males and 22 females aged 23–71 years, with an average age of 53.12 ± 5.34 years. The patients weighed 45.71–87.92kg, with an average weight of 64.23 ± 6.35 kg. The duration of the disease ranged from 1–10 years, with an average duration of 2.73 ± 0.65 years. There were 17 cases of upper limb pain and 29 cases of lower limb pain. General information between the two groups was compared ($P > 0.05$).

#### 2.1.1. Inclusion and exclusion criteria

Inclusion criteria: (1) Patients with a confirmed diagnosis of MACP; (2) patients with complete data; (3) consented. Exclusion criteria: (1) Patients with malignant tumors; (2) mental illness; (3) liver and kidney dysfunction.

### 2.2. Methods

Group A received rehabilitation training treatment. Patients were ordered to lie supine and were subjected to isometric contraction training corresponding to chronic diseases of the upper and lower limbs or lumbar muscle groups, 20 times/group, 10 groups/day. Patients with chronic diseases of the upper and lower limbs or lumbar muscle groups were subjected to joint mobility training for 30 minutes, 2 times/day. Patients with chronic diseases of the upper and lower limbs or lumbar muscle groups were subjected to stretching exercises, where the affected limbs or lumbar muscles were extended fully and held for 5–10 s. This was carried out with 10 groups per session, twice daily. The patients were also subjected to computerized intermediate frequency therapeutic instrument ultrashort wave therapy, for 10 minutes, twice daily. This treatment was performed for 1 month.

Group B received rehabilitation training treatment combined with extracorporeal shock waves based on group A. The parameters of the extracorporeal shock wave pain therapy instrument were set as follows. The impact frequency and pressure at 10–12Hz and 2.0–4.0MPa, respectively. The maximum capacity density of the probe D20 and R15 were set as 0.38MJ/mm$^2$ and 0.48MJ/mm$^2$, respectively. An appropriate probe was then pressed on the affected location. The shock wave treatment was carried out in transverse and longitudinal directions with the pain point as the center. The frequency and pressure of impact were adjusted according to the patient's pain degree and tolerance. The number of shocks was set to 1600–2000 times. This treatment was carried out once every 5 days for 6 times.

## 2.3. Indicator observation

### 2.3.1. Treatment effective rate

Treatment effective rate = significant effect + effective rate. Apparent effect: no pain sensation; effective: significant improvement in pain sensation; ineffective: no improvement in pain.

### 2.3.2. Clinical indicators

The simplified Fugl-Meyer scale was used to evaluate the function of the upper limbs and lower limbs of patients before and after treatment, and the scores were positively correlated with the function. The activities of daily living (ADL) scale was used to evaluate the ability of patients to perform daily activities before and after treatment, and the scores were positively correlated with the ability. The visual analog scale (VAS) was used to evaluate the patient's pain before and after treatment, and the scores were negatively correlated with the pain.

### 2.3.3. SF-36 scale

The short form-36 (SF-36) scale was used to assess the patient's quality of life at 1 month of treatment, and the score and life quality were positively correlated.

## 2.4. Statistical analysis

The SPSS 25.0 software was used to process the data. Measurement data were expressed as mean ± standard deviation and compared using the *t*-test. Count data were expressed as % and analyzed using the chi-squared ($\chi^2$) test. Results were considered statistically significant at $P < 0.05$.

# 3. Results

## 3.1. Comparison of treatment effective rate

As shown in **Table 1**, the treatment effective rate of Group B was higher than that of Group A ($P < 0.05$).

**Table 1.** Comparison of treatment effective rate between the two groups [*n* (%)]

| Group | Cases, *n* | Very effective | Effective | Ineffective | Efficiency |
|---|---|---|---|---|---|
| Group B | 51 | 34 (66.67) | 15 (29.41) | 2 (3.92) | 49 (96.08) |
| Group A | 46 | 20 (43.48) | 18 (39.13) | 8 (17.39) | 38 (82.61) |
| $\chi^2$ | - | - | - | - | 4.745 |
| *P* | - | - | - | - | 0.029 |

## 3.2. Comparison of clinical indicators

As shown in **Table 2**, the comparison of clinical indicators between the two groups before treatment was not significant ($P > 0.05$). After treatment, the clinical indicators of Group B were better than those of Group A ($P < 0.05$).

**Table 2.** Comparison of clinical indicators before and after treatment (mean ± standard deviation, points)

| Group | Cases, *n* | Upper extremity function score (66 points) | | Lower extremity function score (34 points) | | ADL score (100 points) | | VAS score (10 points) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Before treatment | After treatment | Before treatment | After treatment | Before treatment | After treatment | Before treatment | After treatment |
| Group B | 51 | 43.68 ± 4.87 | 54.26 ± 5.47 | 19.64 ± 1.82 | 29.52 ± 2.37 | 73.49 ± 4.12 | 88.62 ± 5.36 | 4.15 ± 0.84 | 1.26 ± 0.37 |
| Group A | 46 | 44.13 ± 4.92 | 49.35 ± 4.86 | 19.35 ± 1.81 | 25.26 ± 2.04 | 73.95 ± 4.18 | 82.37 ± 4.63 | 4.02 ± 0.83 | 2.13 ± 0.54 |
| *t* | - | 0.452 | 4.652 | 0.785 | 9.437 | 0.545 | 6.113 | 0.765 | 9.332 |
| *P* | - | 0.652 | 0.000 | 0.434 | 0.000 | 0.586 | 0.000 | 0.445 | 0.000 |

Note: Comparison with the group before treatment $^*P < 0.05$.

### 3.3. Comparison of SF-36 scores

As shown in **Table 3**, the SF-36 score of Group B was higher than that of Group A at 1 month of treatment ($P < 0.05$).

**Table 3.** Comparison of SF-36 scores between the two groups (mean ± standard deviation, points)

| Group | Cases, *n* | Somatic function | Social function | Physiological function | Psychological function |
|---|---|---|---|---|---|
| Group B | 51 | 86.62 ± 4.13 | 85.84 ± 4.27 | 85.23 ± 4.11 | 86.73 ± 4.21 |
| Group A | 46 | 81.45 ± 3.84 | 81.12 ± 3.89 | 81.36 ± 3.53 | 81.63 ± 3.48 |
| *t* | - | 6.363 | 5.669 | 4.948 | 6.461 |
| *P* | - | 0.000 | 0.000 | 0.000 | 0.000 |

## 4. Discussion

The main triggers of chronic pain are chronic strain injuries and unresolved acute pain. The main sites of attack are the shoulder and knee. The overall number of patients with chronic pain continues to increase due to a combination of factors (accelerated pace of life, increased bad habits, etc.), and the proportion of affected young patients is increasing yearly. Chronic pain can lead to a variety of adverse consequences (decreased sleep quality and appetite, anxiety, etc.), which directly affect the normal work and daily life of patients [5].

Recently, clinics have advocated the use of non-pharmacological protocols for the treatment of chronic pain, such as rehabilitation training therapy, which is an integrated therapy involving physiotherapy, rehabilitation exercises, and topical medications [6]. Physiotherapy is mainly used in the treatment of MACP patients, which can effectively loosen the tendons and muscles in the affected area, improve the performance of muscle tension, improve the rate of blood circulation, and lay the foundation for the subsequent treatment. Physiotherapy also includes the use of topical drugs for fumigation, hot compresses, etc. on the affected area, which relies on the active ingredients of the topical drugs to act on the lesions through the skin and acupoints to promote blood circulation in the local muscles, improve the local inflammation, and increase the speed of tissue absorption of exudate. Rehabilitation exercise can promote the body's rapid recovery of muscle tissue and improve muscle pain compensation. Rehabilitation training treatment combines the above treatment modalities and works synergistically at the pain site to ultimately improve the therapeutic effect. Clinical-related studies have confirmed that MACP patients who undergo rehabilitation training treatment experience alleviated pain symptoms, but the overall effect does not meet expectations [7]. With the continuous optimization of minimally invasive medical technology and equipment, more MACP patients are choosing to undergo extracorporeal shockwave therapy, which is simple to operate and produces quick results.

The extracorporeal shockwave facilitates shallow tissue absorption based on mechanical waves to penetrate the deep tissue. In the process of conversion and transfer of energy, the waves produce different mechanical stress, resulting in the formation of cavitation and biological effects, which leads to a difference in the compressive and tensile stress intensity [8]. Compressive stress acting on cells causes them to undergo elastic denaturation, increasing tissue oxygen uptake; tensile stress loosens the tissues, increases the rate of microcirculation, activates metabolism, alters ion channels, contributes to changes in the polarity of the nerve membrane, and exerts an inhibitory effect on depolarising effects, thus decreasing the sensation of pain [9]. Extracorporeal shockwave therapy was initially used to treat kidney stones. With the continuous optimization of the technology and medical, its scope of application has continued to increase. The use of extracorporeal shock wave therapy for MACP patients has many advantages such as minimal damage to healthy tissues, shorter treatment time, rapid alleviation of pain, fewer adverse effects, and lesser cost.

This study showed that the effective treatment rate of Group B (96.08%) treatment was higher than that of Group A (82.61%) ($P < 0.05$). This confirmed that the combination of extracorporeal shock wave and rehabilitation training treatment for MACP patients was effective. Comparison of upper limb function score, lower limb function score, ADL score, VAS score, and SF-36 score between the two groups before treatment were not significant ($P > 0.05$). After treatment, the upper limb function score (54.26 ± 5.47), lower limb function score (29.52 ± 2.37), ADL score (88.62 ± 5.36), VAS score (1.26 ± 0.37), SF-36 score [somatic function (86.62 ± 4.13), social function (85.84 ± 4.27), physical function (85.23 ± 4.11), and psychological function (86.73 ± 4.21)] was better than that of Group A ($P < 0.05$), further confirming the effectiveness of the combined extracorporeal shockwave and rehabilitation training therapy for MACP patients. The findings of Liu *et al* were similar to those of this paper, affirming the effectiveness of combined extracorporeal shockwave and rehabilitation training treatment for MACP patients, and confirming the significant effect of the combined treatment program on improving the patient's limb function and pain and improving their ability to perform daily activities and quality of life [10]. Specifically analyzed, the combined extracorporeal shock wave therapy for MACP patients gives full play to the physics and medicine of shock waves, in which high-energy shock waves will be applied to the pain site. As muscle and bone tissues have different compositions, the strength of anti-pressure and anti-tension produced by the shock waves on the tissues is different, hence mechanical stresses with different strengths are formed between the muscle and bone tissues, which will cause the denaturation and loosening of soft tissues to be denatured and loosened. This eventually loosens the muscles, fascia, and tendons in the painful area and improves the pain sensation. In addition, this treatment method is non-invasive and does not cause damage to the patient. In this study, group B used an extracorporeal shock wave index, and all the patients did not have any complications, probably because the clinicians used low-energy shock waves in the treatment. This helps avoid complications caused by using high-energy shock waves, such as localized reddening of the skin, the emergence of numbness and tingling, and the aggravation of pain.

## 5. Conclusion

The combined extracorporeal shock wave and rehabilitation training treatment for MACP patients improved their limb function, the ability to perform daily activities of daily living and quality of life, and reduced pain.

## Disclosure statement

The authors declare no conflict of interest.

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