

# EXTRACORPOREAL SHOCKWAVE THERAPY IN SHOULDER INJURIES: PROSPECTIVE STUDY

## USO DE TERAPIA DE ONDAS DE CHOQUE EM DOENÇAS ORTOPÉDICAS DO OMBRO: ESTUDO PROSPECTIVO

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### ABSTRACT

**Objective:** To evaluate the functional results after the use of extracorporeal shockwave therapy (ESWT) in four groups of patients: tendinopathy, partial rotator cuff injury, adhesive capsulitis and calcareous tendinopathy of the rotator cuff at one month and three months after the end of treatment. **Methods:** Case series in which patients were evaluated according to the VAS of pain, range of motion of the shoulder, and functional questionnaires DASH and modified UCLA. **Results:** There was a significant increase in the measure of flexion, lateral rotation and shoulder abduction in the evaluations after treatment in relation to the baseline measurement ( $p < 0.001$ ) and no evidence of significant difference was found between the post-treatment evaluations at one month and three months follow-up ( $p > 0.05$ ). There was a significant reduction in the VAS score, increase in the UCLA score and a significant reduction in the DASH score in the post-treatment evaluations in relation to the baseline score ( $p < 0.001$ ) and a significant improvement in the three-month evaluation in relation to one month ( $p < 0.05$ ). **Conclusion:** Extracorporeal shockwave therapy proved to be efficient and safe in the treatment of shoulder pathologies, improving pain, range of motion and functional scores in all groups of patients evaluated in the study. **Level of Evidence IV, Case series.**

**Keywords:** Shoulder Injuries. Shoulder. Extracorporeal Shockwave Therapy.

### RESUMO

**Objetivo:** Avaliar os resultados funcionais após uso de terapia de ondas de choque (TOC) em quatro grupos de pacientes: tendinopatia, lesão parcial de manguito rotador, capsulite adesiva e tendinopatia calcária do manguito rotador com 1 mês e 3 meses após término do tratamento. **Métodos:** Série de casos, na qual os pacientes foram avaliados de acordo com a EVA da dor, amplitude de movimento do ombro, e questionários funcionais DASH e UCLA modificados. **Resultados:** Houve aumento significativo das medidas de flexão, rotação lateral e abdução do ombro nas avaliações após tratamento, em relação à medida basal ( $p < 0,001$ ) e não houve evidências de variação significativa entre as avaliações pós-tratamento com 1 mês e 3 meses de acompanhamento ( $p > 0,05$ ). Houve redução significativa do escore EVA, aumento do escore UCLA e redução significativa do escore DASH nas avaliações após tratamento em relação ao escore basal ( $p < 0,001$ ) e melhora significativa na avaliação de três meses em relação a um mês ( $p < 0,05$ ). **Conclusão:** A terapia de ondas de choque mostrou-se uma terapia eficiente e segura no tratamento das patologias do ombro, com melhora da dor, arco de movimento e escores funcionais em todos os grupos de pacientes avaliados no estudo. **Nível de Evidência IV, Série de casos.**

**Descritores:** Lesões do Ombro. Ombro. Tratamento por Ondas de Choque Extracorpóreas.

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### INTRODUCTION

Pain complaints that affect the shoulder girdle region are common causes of orthopedic appointments.<sup>1</sup> Among the most common diseases, we mainly have conditions that affect the rotator cuff, such as tendinopathies, partial rotator cuff injuries, calcareous tendinopathies, and adhesive capsulitis.<sup>2</sup> Conservative treatment with medications, physical therapy, acupuncture, anesthetic blocks, and corticosteroid injections is usually the initial treatment and is effective in most cases.<sup>3,4</sup> However, patients resistant to primary treatment are

not always willing or in good clinical condition for surgical treatment, which, in turn, does not always guarantee good results.

The use of alternative therapies, such as shockwave therapy, has been reported with good results in certain groups of patients.<sup>5-8</sup> However, there is still no consensus in the literature about protocols and specific diseases where shockwave therapy is effective. The use of shockwave therapy applied to the musculoskeletal system in Brazil began in 1998 with the arrival of the first urological lithotripsy machines, which were adapted

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The study was conducted at the Orthopedics Institute of Prevent Senior.

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for use in orthopedic injuries. This adaptation consisted in the introduction of a new technology that allowed to grade the depth and force with which shock waves penetrate the human body.<sup>5</sup> The action is determined by the penetration of mechanical waves into tissues, without damage to the skin, vessels and nerves. Upon reaching the injured site, the shock waves promote a mechanical stimulus that induces a series of biological effects, such as: increased production of prostaglandins related to the tissue repair process; increased congestion and local blood microcirculation and increased local nitric oxide concentration with pain relief.<sup>9-12</sup> Thus, the aim of this study is to evaluate the functional outcomes after the use of shockwave therapy (SWT) in four groups of patients: tendinopathy, partial rotator cuff injury, adhesive capsulitis, and rotator cuff calcareous tendinopathy with one month and three months after the end of treatment.

## MATERIALS AND METHODS

This is a prospective study with four groups of patients with the following diseases: 1. Rotator cuff tendinopathy; 2. Shoulder adhesive capsulitis; 3. Calcareous tendinopathy of the shoulder; 4. Partial rotator cuff injury. The Study was submitted and approved by the institution's research ethics committee (number 27245219.8.0000.8114). All patients over 18 years of age were selected from the general orthopedic and shoulder clinic of Prevent Senior and treated between 01/01/2018 and 04/30/2018, with diagnoses confirmed by imaging exams (radiographs, ultrasonography and/or magnetic resonance), who have failed conventional conservative treatment for at least three months. The patient sample was estimated using a 95% confidence interval and 80% power to detect a 15-point difference in the DASH score, with a standard deviation of 10 to 18 in each group and allowing a loss of approximately 20% of patients. In this way we recruited a total of at least 15 individuals in each group.

Patients were evaluated according to the VAS<sup>13</sup> (visual analogue scale) of pain, range of motion (anterior elevation, medial rotation, lateral rotation and abduction) of the shoulder, and functional DASH<sup>14</sup> and modified UCLA questionnaires.<sup>15</sup> Three shockwave therapy sessions were carried out in each patient, with an interval of seven days each, and reassessments after one and three months after the last session. The shockwave therapy sessions were performed by three physicians with prior training in the technique and members of the Brazilian Medical Society of Shockwave Therapy (SMBTOC). All sessions were performed by the same physician.

### Inclusion criteria

- Patients over 18 years old, without distinction of age or gender;
- Present a diagnosis of rotator cuff tendinopathy or partial lesion that affects less than 50% of the thickness or adhesive capsulitis or rotator cuff calcareous tendinopathy;
- Diagnostic confirmation through magnetic resonance;
- Availability of follow-up during the study period (three months);
- Having undergone previous conservative treatment without improvement of symptoms for a minimum period of three months;
- Having signed an informed consent form to participate in the study (Annex 5).

### Exclusion criteria

- Previous surgery on the affected shoulder;
- Injury greater than 50% of the thickness of the rotator cuff;
- Adhesive capsulitis secondary to fracture of the shoulder girdle;
- Secondary osteoarthritis;
- Treatment with corticosteroids in the last two months.

## Statistical analysis

Descriptive statistical analysis of each of the analyzed parameters was performed. Parametric statistical tests were used, as the data are quantitative and continuous. To compare the quantitative variables, the ANOVA test was used. Differences with  $p < 0.05$  were considered to be statistically significant.

## RESULTS

The study sample consisted of 60 patients, of which 6 (six) abandoned the study before the evaluation one month after the first application. Of these six patients, one underwent surgical treatment due to the lack of improvement in the partial cuff lesion before completing the three-month follow-up. The remaining patients (five) started the shockwave therapy, but before the end of the three sessions, they chose to continue with the conservative treatment with medication and physical therapy. We did not observe side effects and complications related to the technique in the patients included in the study. Thus, the results observed in 54 patients with shoulder injury treated with Shockwave Therapy, with first application between May and August 2018, were analyzed.

Participants (Table 1) were aged between 51 and 92 years, with a mean of 63.6 years (SD = 7.5 years). The diagnoses and duration of symptoms before the beginning of the study and the presence of comorbidities of the patients are also shown in Table 1.

**Table 1.** Characteristics of patients with shoulder injury treated with Shockwave Therapy.

|                     |             |
|---------------------|-------------|
| Age (years)         | n = 54      |
| mean (SD)           | 63.6 (7.5)  |
| median (Q1; Q3)     | 62 (58; 67) |
| minimum, maximum    | 51; 92      |
| Age group           |             |
| 50 to 59 years      | 17 (31.5%)  |
| 60 to 69 years      | 28 (51.9%)  |
| 70 years or older   | 9 (16.7%)   |
| Gender              |             |
| Male                | 13 (24.1%)  |
| Female              | 41 (75.9%)  |
| Diagnostic          |             |
| MR tendinopathy     | 12 (22.2%)  |
| MR partial injury   | 18 (33.3%)  |
| Adhesive capsulitis | 12 (22.2%)  |
| Calcific tendonitis | 12 (22.2%)  |
| Affected side       |             |
| Right               | 34 (63.0%)  |
| Left                | 20 (37.0%)  |
| Dominance           |             |
| Right               | 51 (94.4%)  |
| Left                | 3 (5.6%)    |
| Symptoms time       |             |
| 3 to 6 months       | 9 (16.7%)   |
| 6 to 12 Months      | 16 (29.6%)  |
| 12 to 24 months     | 16 (29.6%)  |
| more than 24 months | 13 (24.1%)  |
| Comorbidities       |             |
| Yes                 | 48 (88.9%)  |
| No                  | 6 (11.1%)   |
| Surgery             |             |
| No                  | 54 (100.0%) |

SD: standard deviation; Q1: first quartile; Q3: third quartile.

Patients were evaluated for range of motion measurements at baseline, one month and three months after treatment (Table 2).

**Table 2.** Estimated mean values and confidence intervals (95%CI) during follow-up for the range of motion measurements of patients with shoulder injury treated with Shockwave Therapy.

| Range of Motion (RM)   | Evaluation           |                      |                      |
|------------------------|----------------------|----------------------|----------------------|
|                        | Baseline (n = 54)    | 1 month (n = 54)     | 3 months (n = 54)    |
| Previous elevation (°) | 121.9 (112.9; 131.7) | 143.7 (135.3; 152.7) | 145.7 (137.4; 154.6) |
| Differences            |                      |                      |                      |
| 1 month – Baseline     | 21.8 (12.7; 30.9)    | p < 0.001            |                      |
| 3 months – Baseline    | 23.8 (13.4; 34.2)    | p < 0.001            |                      |
| 3 months – 1 month     | 2.0 (-4.4; 8.5)      | P = 0.536            |                      |
| Lateral rotation (°)   | 53.5 (48.4; 59.1)    | 63.3 (58.0; 69.1)    | 64.4 (58.9; 70.3)    |
| Differences            |                      |                      |                      |
| 1 month – Baseline     | 9.8 (2.0; 17.7)      | p = 0.010            |                      |
| 3 months – Baseline    | 10.8 (2.8; 18.9)     | p = 0.004            |                      |
| 3 months – 1 month     | 1.0 (-2.3; 4.4)      | p = 0.550            |                      |
| Abduction (°)          | 72.1 (67.9; 76.6)    | 83.6 (81.1; 86.2)    | 85.0 (82.6; 87.4)    |
| Differences            |                      |                      |                      |
| 1 month – Baseline     | 11.5 (6.4; 16.6)     | p < 0.001            |                      |
| 3 months – Baseline    | 12.9 (7.4; 18.3)     | p < 0.001            |                      |
| 3 months – 1 month     | 1.4 (-0.6; 3.4)      | p = 0.179            |                      |

Values expressed as estimated means and 95% confidence intervals; p values corrected by the sequential Bonferroni method.

We found evidence of a significant increase in the measurement of anterior elevation, lateral rotation and shoulder abduction in the post-treatment assessments compared to the baseline measurement (p < 0.001) and there was no evidence of significant variation between the post-treatment assessments at one month and three months follow-up (p > 0.05).

Pain and function assessment instruments were applied to patients at baseline, one month and three months after treatment (Table 3).

**Table 3.** Estimated mean values and confidence intervals (95%CI) during follow-up for pain and function scores of patients with shoulder injury treated with Shockwave Therapy.

| Instrument scores   | Evaluation           |                   |                   |
|---------------------|----------------------|-------------------|-------------------|
|                     | Baseline (n = 54)    | 1 month (n = 54)  | 3 months (n = 54) |
| VAS                 | 6.9 (6.4; 7.4)       | 4.8 (4.1; 5.5)    | 3.4 (2.7; 4.1)    |
| Differences         |                      |                   |                   |
| 1 month – Baseline  | -2.1 (-2.9; -1.3)    | p < 0.001         |                   |
| 3 months – Baseline | -3.5 (-4.4; -2.7)    | p < 0.001         |                   |
| 3 months – 1 month  | -1.4 (-2.1; -0.8)    | p < 0.001         |                   |
| UCLA                | 43.3 (40.3; 46.6)    | 69.0 (64.7; 73.6) | 74.6 (68.9; 80.8) |
| Differences         |                      |                   |                   |
| 1 month – Baseline  | 25.7 (20.4; 30.9)    | p < 0.001         |                   |
| 3 months – Baseline | 31.3 (24.9; 37.6)    | p < 0.001         |                   |
| 3 months – 1 month  | 5.6 (0.8; 10.5)      | p = 0.024         |                   |
| DASH                | 57.3 (53.3; 61.6)    | 40.5 (35.5; 46.3) | 34.1 (28.8; 40.3) |
| Differences         |                      |                   |                   |
| 1 month – Baseline  | -16.8 (-22.8; -10.7) | p < 0.001         |                   |
| 3 months – Baseline | -23.2 (-30.0; -16.4) | p < 0.001         |                   |
| 3 months – 1 month  | -6.4 (-11.9; -1.0)   | p = 0.021         |                   |

Values expressed as estimated means and 95% confidence intervals; p values corrected by the sequential Bonferroni method.

We observed evidence of a significant reduction in the VAS score, an increase in the UCLA score and a significant reduction in the DASH score in the post-treatment assessments compared to the baseline score (p < 0.001) and a significant improvement in the three-month evaluation compared to the one-month evaluation (p < 0.05).

We investigated the relation between VAS scores at baseline, one month and three months after treatment, and patient characteristics (Table 4).

**Table 4.** Estimated mean values and confidence intervals (95%CI) during follow-up for the VAS score according to the characteristics of patients with shoulder injury treated with Shockwave Therapy.

| VAS score Characteristics of patients     | Evaluation     |                |                |
|---|----------------|----------------|----------------|
|   | Baseline       | 1 month        | 3 months       |
| Gender                                    |                |                |                |
| Male                                      | 6.7 (5.7; 7.7) | 4.2 (3.0; 5.4) | 2.9 (1.4; 4.5) |
| Female                                    | 7.0 (6.4; 7.5) | 5.0 (4.1; 5.8) | 3.5 (2.7; 4.3) |
| Comparisons                               |                |                |                |
| Male × Female                             | p = 0.649      | p = 0.331      | p = 0.506      |
| Age group                                 |                |                |                |
| 50 to 59 years                            | 6.7 (5.9; 7.5) | 4.5 (3.3; 5.8) | 3.2 (1.9; 4.5) |
| 60 to 69 years                            | 7.1 (6.5; 7.7) | 4.9 (3.9; 5.8) | 3.8 (2.8; 4.8) |
| 70 years or older                         | 6.7 (5.1; 8.3) | 4.9 (3.4; 6.4) | 2.3 (1.2; 3.4) |
| Comparisons                               |                |                |                |
| 50-59 a × 60-69 a                         | p > 0.999      | p > 0.999      | p = 0.598      |
| 50-59 a × ≥ 70 a                          | p > 0.999      | p > 0.999      | p = 0.598      |
| 60-69 a × ≥ 70 a                          | p > 0.999      | p > 0.999      | p = 0.179      |
| Diagnostic                                |                |                |                |
| MR tendinopathy                           | 6.8 (5.6; 7.9) | 5.0 (3.5; 6.5) | 3.1 (1.6; 4.6) |
| MR partial injury                         | 6.9 (6.0; 7.9) | 4.4 (3.4; 5.4) | 3.2 (2.3; 4.2) |
| Adhesive capsulitis                       | 6.3 (5.8; 6.7) | 4.3 (2.6; 6.1) | 2.8 (1.4; 4.1) |
| Calcific tendonitis                       | 7.6 (6.6; 8.6) | 5.6 (4.4; 6.8) | 4.5 (2.6; 6.4) |
| Comparisons                               |                |                |                |
| MR tendinopathy × MR partial lesion       | p > 0.999      | p > 0.999      | p > 0.999      |
| MR tendinopathy × Adhesive capsulitis     | p > 0.999      | p > 0.999      | p > 0.999      |
| MR tendinopathy × Calcific tendonitis     | p > 0.999      | p > 0.999      | p > 0.999      |
| MR partial lesion × Adhesive capsulitis   | p > 0.999      | p > 0.999      | p > 0.999      |
| MR partial lesion × Calcific tendonitis   | p > 0.999      | p = 0.849      | p > 0.999      |
| Adhesive capsulitis × Calcific tendonitis | p > 0.119      | p > 0.999      | p = 0.856      |
| Symptoms Time                             |                |                |                |
| 3 to 6 months                             | 6.2 (5.1; 7.4) | 3.6 (2.2; 4.9) | 3.0 (1.4; 4.6) |
| 6 to 12 months                            | 6.8 (5.9; 7.7) | 4.6 (3.4; 5.7) | 3.1 (1.8; 4.4) |
| 12 to 24 months                           | 7.1 (6.3; 7.9) | 5.8 (4.4; 7.1) | 3.0 (1.9; 4.1) |
| more than 24 months                       | 7.2 (6.2; 8.3) | 4.7 (3.4; 6.0) | 4.4 (2.8; 6.0) |
| Comparisons                               |                |                |                |
| 3-6 m × 6-12 m                            | p > 0.999      | p = 0.975      | p > 0.999      |
| 3-6 m × 12-24 m                           | p > 0.999      | p = 0.158      | p > 0.999      |
| 3-6 m × > 24 m                            | p > 0.999      | p = 0.975      | p > 0.999      |
| 6-12 m × 12-24 m                          | p > 0.999      | p = 0.933      | p > 0.999      |
| 6-12 m × > 24 m                           | p > 0.999      | p = 0.975      | p > 0.999      |
| 12-24 m × > 24 m                          | p > 0.999      | p = 0.975      | p = 0.999      |

Values expressed as estimated means and 95% confidence intervals; p values corrected by the sequential Bonferroni method

We observed that in all the diseases studied there was an improvement in VAS. In rotator cuff tendinopathy, there was an improvement from 6.8 to 3.1 at the end of the follow-up. In the partial rotator cuff injury, there was an improvement from 6.9 to 3.2 at the end of the follow-up. In the adhesive capsule there was an improvement from 6.3 to 2.8 at the end of the follow-up. In calcareous tendinitis there was an improvement from 7.6 to 4.5 at the end of the follow-up. We found no significant differences in mean VAS scores at baseline, one month and three months after treatment, between male and female, age, diagnostic, and symptom time groups ( $p > 0.05$  in all comparisons in the three evaluations).

Table 5 shows the relationship between UCLA scores at baseline, one month and three months after treatment, and patient characteristics.

**Table 5.** Estimated mean values and confidence intervals (95%CI) during follow-up for the UCLA score according to the characteristics of patients with shoulder injury treated with Shockwave Therapy.

| UCLA score<br>Characteristics of patients | Evaluation           |                      |                      |
|---|----------------------|----------------------|----------------------|
|   | Baseline             | 1 month              | 3 months             |
| Gender                                    |                      |                      |                      |
| Male (n = 13)                             | 45.1<br>(38.9; 52.2) | 72.3<br>(64.9; 80.6) | 80.0<br>(70.5; 90.8) |
| Female (n = 41)                           | 42.8<br>(39.3; 46.5) | 67.9<br>(62.9; 73.4) | 72.9<br>(66.2; 80.3) |
| Diagnostic                                |                      |                      |                      |
| MR tendinopathy (n = 12)                  | 41.2<br>(34.6; 49.0) | 69.8<br>(61.1; 79.6) | 74.3<br>(61.9; 89.3) |
| MR partial lesion (n = 18)                | 44.4<br>(39.8; 49.6) | 73.3<br>(68.0; 79.1) | 80.6<br>(73.5; 88.5) |
| Adhesive capsulite (n = 12)               | 44.5<br>(38.2; 51.8) | 68.8<br>(57.3; 82.7) | 75.0<br>(64.4; 87.4) |
| Calcareous tendinitis (n = 12)            | 42.6<br>(36.1; 50.3) | 61.9<br>(54.7; 70.1) | 65.5<br>(52.2; 82.2) |

Values expressed as estimated means and 95% confidence intervals; p values corrected by the sequential Bonferroni method.

We observed that in all diseases studied there was an improvement in the UCLA score. In rotator cuff tendinopathy, there was an improvement from 41.2 to 74.3 at the end of the follow-up. In the partial rotator cuff injury, there was an improvement from 44.4 to 80.6 at the end of the follow-up. In the adhesive capsule there was an improvement from 44.5 to 75 at the end of the follow-up. In calcareous tendinitis there was an improvement from 42.6 to 65.5 at the end of the follow-up. We found no significant differences in mean VAS scores at baseline, one month and three months after treatment, between male and female, age, diagnostic, and symptom time groups ( $p > 0.05$  in all comparisons in the three evaluations).

Table 6 shows the relation between DASH scores at baseline, one month and three months after treatment, and patient characteristics. We observed that in all diseases studied there was an improvement in the DASH score. In rotator cuff tendinopathy, there was an improvement from 63 to 33.6 at the end of the follow-up. In the partial rotator cuff injury, there was an improvement from 53.2 to 33.5 at the end of the follow-up. In the adhesive capsule, there was an improvement from 58.8 to 29.7 at the end of the follow-up. In calcareous tendinitis there was an improvement from 56.2 to 39.8 at the end of the follow-up. We found no significant differences in mean VAS scores at baseline, one month and three months after treatment, between male and female, age, diagnostic, and symptom time groups ( $p > 0.05$  in all comparisons in the three evaluations).

**Table 6.** Estimated mean values and confidence intervals (95%CI) during follow-up for the UCLA score according to the characteristics of patients with shoulder injury treated with Shockwave Therapy.

| UCLA score<br>Characteristics of patients   | Evaluation           |                      |                      |
|---|----------------------|----------------------|----------------------|
|   | Baseline             | 1 month              | 3 months             |
| Gender                                      |                      |                      |                      |
| Male  | 45.1<br>(38.9; 52.2) | 72.3<br>(64.9; 80.6) | 80.0<br>(70.5; 90.8) |
| Female                                      | 42.8<br>(39.3; 46.5) | 67.9<br>(62.9; 73.4) | 72.9<br>(66.2; 80.3) |
| Comparisons                                 |                      |                      |                      |
| Male × Female                               | p = 0.556            | p = 0.361            | p = 0.260            |
| Age group                                   |                      |                      |                      |
| 50 to 59 years                              | 47.1<br>(42.4; 52.2) | 69.9<br>(62.8; 77.9) | 75.5<br>(66.5; 85.7) |
| 60 to 69 years                              | 43.1<br>(38.7; 48.0) | 68.7<br>(62.5; 75.5) | 73.9<br>(65.7; 83.1) |
| 70 years or older                           | 37.1<br>(31.2; 44.2) | 68.3<br>(59.2; 78.8) | 75.3<br>(62.4; 90.7) |
| Comparisons                                 |                      |                      |                      |
| 50-59 a × 60-69 a                           | p = 0.287            | p > 0.999            | p > 0.999            |
| 50-59 a × ≥ 70 a                            | p = 0.048            | p > 0.999            | p > 0.999            |
| 60-69 a × ≥ 70 a                            | p = 0.287            | p > 0.999            | p > 0.999            |
| Diagnostic                                  |                      |                      |                      |
| MR tendinopathy                             | 41.2<br>(34.6; 49.0) | 69.8<br>(61.1; 79.6) | 74.3<br>(61.9; 89.3) |
| MR partial injury                           | 44.4<br>(39.8; 49.6) | 73.3<br>(68.0; 79.1) | 80.6<br>(73.5; 88.5) |
| Adhesive capsulitis                         | 44.5<br>(38.2; 51.8) | 68.8<br>(57.3; 82.7) | 75.0<br>(64.4; 87.4) |
| Calccific tendonitis                        | 42.6<br>(36.1; 50.3) | 61.9<br>(54.7; 70.1) | 65.5<br>(52.2; 82.2) |
| Comparisons                                 |                      |                      |                      |
| MR tendinopathy × MR partial lesion         | p > 0.999            | p > 0.999            | p > 0.999            |
| MR tendinopathy × Adhesive capsulitis       | p > 0.999            | p > 0.999            | p > 0.999            |
| MR tendinopathy × Calcareous tendinitis     | p > 0.999            | p = 0.997            | p > 0.999            |
| MR partial lesion × Adhesive capsulitis     | p > 0.999            | p > 0.999            | p > 0.999            |
| MR partial lesion × Calcareous tendinitis   | p > 0.999            | p = 0.109            | p = 0.443            |
| Adhesive capsulitis × Calcareous tendinitis | p > 0.999            | p > 0.999            | p > 0.999            |
| Symptoms Time                               |                      |                      |                      |
| 3 to 6 months                               | 47.6<br>(43.5; 52.1) | 72.1<br>(65.9; 78.8) | 80.0<br>(66.3; 96.5) |
| 6 to 12 months                              | 43.6<br>(39.1; 48.5) | 75.9<br>(69.7; 82.7) | 81.6<br>(73.1; 91.1) |
| 12 to 24 months                             | 43.6<br>(37.1; 51.2) | 60.2<br>(51.7; 70.0) | 70.2<br>(60.8; 81.1) |
| more than 24 months                         | 39.8<br>(33.3; 47.5) | 69.2<br>(60.8; 78.9) | 67.7<br>(55.8; 82.1) |
| Comparisons                                 |                      |                      |                      |
| 3-6 m × 6-12 m                              | p > 0.999            | p = 0.822            | p > 0.999            |
| 3-6 m × 12-24 m                             | p > 0.999            | p = 0.186            | p = 0.902            |
| 3-6 m × > 24 m                              | p = 0.381            | p = 0.822            | p = 0.902            |
| 6-12 m × 12-24 m                            | p > 0.999            | p = 0.035            | p = 0.514            |
| 6-12 m × > 24 m                             | p > 0.999            | p = 0.717            | p = 0.514            |
| 12-24 m × > 24 m                            | p > 0.999            | p = 0.668            | p > 0.999            |

Values expressed as estimated means and 95% confidence intervals; p values corrected by the sequential Bonferroni method

## DISCUSSION

Shockwave therapy showed improvement in pain parameters, range of motion and functional scores in relation to the studied shoulder pathologies. In addition, no significant difference was found in the results regarding gender, age, diagnosis and previous time of symptoms, which shows that this is a treatment option that can be used in the vast majority of patients with shoulder conditions, with good results. The use of shock wave therapies in tendinopathies and partial rotator cuff injuries is not a consensus, there is still a lack of quality studies proving their effectiveness in this group of patients.<sup>16</sup> In the study by Chou et al.,<sup>17</sup> there was a significant improvement in the pain scale and functional scores in athlete and non-athlete patients with tendinopathies and partial rotator cuff injuries undergoing treatment with shock waves. In the study by Frizziero et al.,<sup>18</sup> a comparison was made between shockwave therapy and intra-articular hyaluronic acid infiltration for the treatment of rotator cuff tendinopathy, with both showing good results. However, infiltration led to faster results and shockwave therapy led to longer lasting results. Specifically regarding rotator cuff tendinopathy compared to placebo, there are studies showing good results in favor of shockwave therapy,<sup>19,20</sup> while others show similar results between placebo and shockwave therapies.<sup>21,22</sup> In our study, there were good results with statistical significance in relation to shockwave therapy in all groups, although the study does not present a control group.

Regarding capsulitis, the study by Muthukrishnan, Rashid and Al-Alkharji<sup>23</sup> compared shockwave therapy with ultrasound therapy in the treatment of diabetic patients with adhesive capsulitis, and a significant reduction in pain and treatment costs was found in patients undergoing treatment with shock waves. In the study by Chen et al.,<sup>24</sup> there was a comparison between shockwave therapy and the use of oral steroids in the treatment of adhesive capsulitis, with both showing favorable results, with the oral steroid group showing faster results. In our study, there were favorable results both in terms of pain and improvement in functional scores in all evaluated groups.

In relation to calcifying tendonitis, there are a greater number of studies with favorable results. Duymaz and Sindel<sup>25</sup> compared shockwave therapy and physical therapy in the treatment of calcific

tendonitis, and there was a better result in the shockwave therapy group in relation to pain, gain in range of motion and improvement in functional score. In the study by Tornese et al.,<sup>10</sup> arm positions were compared (neutral position × hyperextension and medial rotation) during shockwave therapy. In the hyperextension and medial rotation group there was a higher percentage of subtotal or total reabsorption of calcium deposits (66.6% versus 35.3%), which was positively related to clinical outcomes. In this study, patients underwent shockwave therapy sessions with the arm in a neutral position. In accordance with previous studies,<sup>26,27</sup> ours showed an improvement in pain, range of motion and functional scores in patients with calcific tendonitis who underwent treatment with shockwave therapy.

There were good results in the four groups of diseases, both in diseases with few studies that evaluated the use of shockwave therapy as an adhesive capsule and in diseases with a greater number of studies, such as calcareous tendonitis. Another important aspect is that the results were similar in all age groups studied, showing that it is a treatment modality that can be used at different ages. Furthermore, there was no difference in the results regarding the duration of symptoms, which shows that shockwave therapy can be used in both more acute and chronic conditions.

This is the first national study to evaluate shockwave therapy in major shoulder diseases. Our study has some limitations, such as the fact that there is no comparison group (control group), however, in this first study, we wanted to evaluate the response of shockwave therapy in shoulder pathologies and, in the next step, we will carry out the comparative evaluation of this modality with other treatments. Another limitation is the three-month follow-up time, which allows an assessment of the therapeutic response but does not allow to assess whether the improvement is maintained in the long term.

## CONCLUSION

Shockwave therapy proved to be an efficient and safe therapy, in the short term, in the treatment of shoulder pathologies, with improvement in pain, range of motion and functional scores in all groups of patients evaluated in the study.

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