

# Progressive Resistance Training in Patients With Shoulder Impingement Syndrome: A Randomized Controlled Trial

IMPÉRIO LOMBARDI, JR., ÂNGELA GUARNIERI MAGRI, ANNA MARIA FLEURY,  
ANTONIO CARLOS DA SILVA, AND JAMIL NATOUR

**Objective.** To assess pain, function, quality of life, and muscle strength in patients with shoulder impingement syndrome who participated in muscle strengthening exercises.

**Methods.** A total of 60 patients diagnosed with shoulder impingement syndrome were selected from the clinics of the Federal University of São Paulo and randomly distributed into experimental and control groups. Patients were evaluated regarding pain, function, quality of life, muscle strength, and the number of antiinflammatory drugs and analgesics taken. Patients then participated in the progressive resistance training program for the musculature of the shoulder, which was held twice a week for 2 months, while the control group remained on a waiting list.

**Results.** Sixty patients were randomly allocated to the experimental group (21 women and 9 men, mean age 56.3 years) and control group (25 women and 5 men, mean age 54.8 years). Patients from the experimental group showed an improvement from 4.2 cm to 2.4 cm on a 10-cm visual analog scale ( $P < 0.001$ ) regarding pain at rest and from 7.4 cm to 5.2 cm ( $P < 0.001$ ) regarding pain during movement. Function went from 44.0 to 33.2 ( $P < 0.007$ ) using the Disabilities of the Arm, Shoulder, and Hand assessment and domains from the Short Form 36. There was a statistically significant difference in improvement in pain and function between patients in the experimental group and those in the control group ( $P < 0.05$ ).

**Conclusion.** The progressive resistance training program for the musculature of the shoulder in patients with shoulder impingement syndrome was effective in reducing pain and improving function and quality of life.

## INTRODUCTION

Tendinitis of the rotator cuff and shoulder impingement syndrome are considered the most common intrinsic causes of shoulder pain and disability (1,2). The upper limbs perform a number of functions related to activities of daily living and labor (3). Shoulder problems are among the most common peripheral complications, and activities in which the arms or hands are used increase the risk of developing shoulder pain (4). It is estimated that the incidence of shoulder problems ranges 7–25 per 1,000 consultations with general physicians (2). The prevalence of shoulder pain among adults younger than 70 years of age is

7–27%, whereas this figure is between 13.2–26% among those older than age 70 (5).

Interest in resistance training received a considerable boost during World War II, when DeLorme demonstrated the importance of progressive resistance training for improving muscle strength and hypertrophy during rehabilitation programs for soldiers (6). Progressive resistance training is the gradual increase of load. Tolerance to exercises should be monitored by the health care professional and adapted to the individual. The following items should be considered in order to achieve an increase in strength, improved resistance, and muscle hypertrophy: 1) an increase in local resistance, 2) number of repetitions, 3) speed of repetitions, 4) rest period, and 5) volume of training (number of repetitions  $\times$  resistance and number of repetitions  $\times$  sets and number of sets per exercise) (7). Progressive resistance training is a muscle strengthening method. The term progressive resistance training is as yet little used in physiotherapy. A number of studies that used the term strengthening in fact used progressive resistance training. Because strengthening is a generic term and has received criticism for being a vague term that most often fails to define the type of strengthening used (8), Taylor et

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Império Lombardi, Jr., PhD, Ângela Guarnieri Magri, PT, Anna Maria Fleury, PT, Antonio Carlos Da Silva, PhD, Jamil Natour, PhD, MD: Federal University of São Paulo, São Paulo, Brazil.

Address correspondence to Jamil Natour, PhD, MD, Rheumatology Division, Rua Botucatu, 740, 04023-900 São Paulo, SP, Brazil. E-mail: jnatour@reumato.epm.br.

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al (9) suggest that progressive resistance training be used for this specific type of strengthening.

Progressive resistance training appears to be a safe and effective form of intervention for patients with muscle strength deficit, but further evidence is needed to determine whether this type of exercise can improve function and quality of life (9). Progressive resistance training improves muscle strength and physical capacity in elderly individuals, but benefits with regard to disability and quality of life remain unclear (10). A number of systematic reviews on studies involving shoulder interventions have found little evidence of exercise used in the treatment of shoulder impingement syndrome. Furthermore, when exercises have been used, the greatest criticism is the lack of detailed description regarding such exercises (11–13).

The goal of the present study was to assess pain, function, muscle strength, and quality of life in patients with shoulder impingement syndrome who have participated in progressive resistance training.

## PATIENTS AND METHODS

Sixty outpatients were selected from the clinics of the Federal University of São Paulo. Patients had demonstrated a positive Neer test and Hawkins test for the diagnosis of shoulder impingement syndrome in the previous 2 months and pain between 3 and 8 on the numeric pain scale in the arc of movement that produces the greatest shoulder pain. A positive Neer test occurs if the patient reports pain when performing passive elevation (14); a positive Hawkins test occurs if the patient reports pain when the arm is flexed at 90° and passively positioned in internal rotation (15). Patients with a history of shoulder fractures or dislocation; cervical radiculopathy; degenerative joint disease of the glenohumeral joint; surgery on the shoulder, back, or thorax; inflammatory arthropathy; infiltration of the shoulder in the previous 3 months; and those undergoing any type of physical intervention for the shoulder were excluded from the study. Selected patients signed an informed consent form. The study was approved by the Ethics Committee of the Universidade Federal de São Paulo. A computer-generated randomization list was utilized to randomly allocate patients into experimental and control groups and a concealed randomization with an opaque sealed envelope was performed.

Evaluations were carried out at the beginning and end of the treatment program by the same blinded examiner for both groups and consisted of the following instruments. Pain at rest and during movement was measured by a visual analog scale ranging from 0 cm for no pain to 10 cm for unbearable pain (16). Function was assessed using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, which comprises 30 items that assess function and symptoms; the DASH 2 is used for laborious function and the DASH 3 for activities of daily living. There are 2 additional modules, one for musicians and athletes and another for laborers. Scores range from 0 to 100, where 0 is considered the best state and 100 represents the worst state (17). In the present study, we called the optional module DASH 2, which refers to the module for laborers, and we

called the 30 items related to function DASH 3, which is used for activities of daily living. We did not use the part of the DASH that is intended for individuals who practice musical instruments or sports, because we had no patients that pertained to this category. Quality of life was assessed using the Brazilian version of the Short Form 36 (SF-36) (18). Shoulder range of motion (ROM) was assessed through active goniometry (19), carried out with patients in a standing position and movements performed against the pull of gravity. Isokinetic assessment of the shoulder joint was performed using the Cybex 6000 isokinetic dynamometer (Cybex, Division of Lumex, Ronkonkoma, NY) and was carried out bilaterally on the 3 planes of movement, following the recommendations for specific positioning in the user's manual, at velocities of 60°/second and 180°/second, as these were used in other studies of patients with shoulder injuries (20). The number of analgesic and nonsteroidal antiinflammatory drugs (NSAIDs) taken by patients was recorded. The degree of patient satisfaction was assessed at the end of the treatment period using a Likert scale with the following items: much worse, a little worse, unchanged, a little better, and much better.

The patients in the experimental group participated in the muscle strength assessment using a repetition maximum (RM) exercise in which patients performed 6 repetitions with the maximum bearable weight, thereby determining the 6 repetition maximum (6 RM) (7). Once the 6 RM load was determined, training was divided into the following regimen: 2 series of 8 repetitions, the first series with 50% of the 6 RM and the second series with 70% of the 6 RM, respecting the patient's pain threshold; the exercise was interrupted if the patient felt pain and performed another movement. Between the first and second series, there was a resting period of 2 minutes; the speed of movement was 2 seconds for both the eccentric and concentric phases. The exercises were flexion, extension, medial rotation, and lateral rotation of the shoulder. Training was carried out twice a week for a period of 8 weeks. The 6 RM load was reevaluated every 2 weeks.

Multipulley muscle-building equipment was used for the exercises. To strengthen the flexors of the shoulder, the patient was positioned with his or her back to the equipment and the elbow flexed at 90°; the patient performed the flexion movement of the shoulder from 0° to 90°. In the extensor strengthening exercise, the patient faced the equipment with the elbow flexed at 45° and the shoulder at 60° of flexion and 30° of extension. In the strengthening of the medial and lateral rotators, the patient was positioned alongside the equipment with the elbow flexed at 90°; for the medial rotation, the patient started at 45° of lateral rotation and moved to 45° of medial rotation; for the lateral rotation, the patient began the movement at 45° of medial rotation and moved to 30° of lateral rotation.

Patients in the control group remained on a waiting list and were informed that they would receive physiotherapeutic treatment after 2 months had passed.

All patients (experimental and control) were told to take 750 mg of acetaminophen every 8 hours when experiencing pain. In cases where the pain surpassed 7 on the visual pain scale, the patient could take 50 mg of diclofenac every

**Table 1. Baseline mean  $\pm$  SD values regarding pain while at rest, pain during movement, DASH 2, and DASH 3\***

	Control group	Experimental group	<i>P</i>
Age, years	54.8 $\pm$ 9.4	56.3 $\pm$ 11.6	0.585
Duration of symptoms, months	13.9 $\pm$ 9.3	13.7 $\pm$ 9.6	0.475
Pain at rest (0–10-cm VAS)	3.9 $\pm$ 2.6	4.2 $\pm$ 2.4	0.630
Pain during movement (0–10-cm VAS)	7.1 $\pm$ 1.5	7.4 $\pm$ 1.0	0.999
DASH 2	47.4 $\pm$ 24.7	49.6 $\pm$ 23.5	0.469
DASH 3	44.8 $\pm$ 18.3	44.0 $\pm$ 17.6	0.573

\* DASH 2 = Disabilities of the Arm, Shoulder, and Hand optional module 2; DASH 3 = Disabilities of the Arm, Shoulder, and Hand referent of 30 questions; VAS = visual analog scale.

8 hours until the pain reached a 5 on the pain scale. This was done at the patient's discretion.

**Statistical analysis.** The significance level was set at 5%, with a power of 90% and an SD of 3.2 points for pain, as presented by Conroy and Hayes (21). To detect 2-point differences on the visual pain scale, a minimum of 27 patients was required for each group. Considering a possible loss of 10% of the patients, we determined that each group would contain 30 patients. The age variable was considered and had normal distribution. Student's *t*-test for independent samples was used. The Mann-Whitney test was used for the following variables, which were not considered as having normal distribution: duration of symptoms, number of antiinflammatory pills, and number of analgesic pills.

Analysis of variance for repeated measures (22) was used to study the intergroup behavior over time considering a relationship between evaluations performed in a single individual. In cases of interruption or abandonment of treatment, the data were analyzed as intent-to-treat. The linear-by-linear association test was used for comparison of the groups regarding the assessment of the evolution of pain using the Likert scale (23).

## RESULTS

Sixty patients were randomly assigned to the experimental and control groups, with 30 patients in each group. Four patients from the control group failed to finish the study: 1 who started having difficulties appearing at the rehabilita-

tion center but appeared for the final evaluation, and 3 who failed to return for the final evaluation, stating difficulties appearing at the evaluation locale. Data from the prior evaluation of the patients from the control group were used for the intent-to-treat analysis. Patients' age, duration of symptoms, pain while at rest, pain during movement, and functional evaluation with the DASH are displayed in Table 1.

The groups were homogeneous at the beginning of treatment with regard to age, duration of symptoms, pain during movement, pain at rest, DASH 2, and DASH 3 (Table 1). Patients in the control group exhibited no statistically significant differences in pain at rest, pain during movement, DASH 2, and DASH 3 between the beginning and end of the study period ( $P = 0.255, 0.304, 0.731,$  and  $0.855$ , respectively). The experimental group exhibited statistically significant improvements over time in comparison with the control group regarding pain at rest, pain during movement, DASH 2, and DASH 3 ( $P = 0.001, 0.001, 0.007,$  and  $0.013$ , respectively). Although the improvement of the experimental group over the control group was the most relevant finding, the experimental group also exhibited statistically significant intragroup improvements when comparing the same variables at the beginning and end of the treatment ( $P < 0.05$ ) (Table 2).

Regarding the number of analgesic pills and NSAIDs taken throughout the study period, the control group took an average of 17.4 NSAIDs and 14.4 analgesics, whereas the experimental group took an average of 1.9 NSAIDs and 2.0 analgesics. This difference was statistically significant ( $P < 0.001$  for NSAIDs and  $P < 0.041$  for analgesics).

**Table 2. Baseline mean  $\pm$  SD values regarding pain while at rest, pain during movement, DASH 2, and DASH 3 with inter- and intragroup comparisons of the beginning and end of treatment\***

	Control group			Experimental group			<i>P</i> (between groups)
	Baseline	After 2 months	<i>P</i> (within group)	Baseline	After 2 months	<i>P</i> (within group)	
Pain at rest (0–10-cm VAS)	3.9 $\pm$ 2.6	4.3 $\pm$ 3.2	0.255	4.2 $\pm$ 2.4	2.4 $\pm$ 2.1	0.001	0.001
Pain at movement (0–10-cm VAS)	7.1 $\pm$ 1.5	7.1 $\pm$ 2.5	0.304	7.4 $\pm$ 1.0	5.2 $\pm$ 2.0	0.002	0.001
DASH 2	47.4 $\pm$ 24.7	44.2 $\pm$ 28.2	0.731	49.6 $\pm$ 23.5	28.7 $\pm$ 24.8	0.032	0.007
DASH 3	44.8 $\pm$ 18.3	43.4 $\pm$ 22.8	0.855	44.0 $\pm$ 17.6	33.2 $\pm$ 18.7	0.046	0.013

\* Analysis of variance for repeated measures was used. See Table 1 for definitions.

**Table 3. Mean  $\pm$  SD goniometry values of the experimental and control groups in the movements of the affected side\***

	Control group		Experimental group		<i>P</i> (between groups)
	Baseline	After 2 months	Baseline	After 2 months	
Flexion	119.5 $\pm$ 29.0	130.6 $\pm$ 27.4	126.7 $\pm$ 24.4	137.1 $\pm$ 24.8	0.901
Abduction	129.7 $\pm$ 31.5	127.2 $\pm$ 31.6	116.8 $\pm$ 24.5	136.9 $\pm$ 28.5	0.001
Medial rotation with shoulder at 90° abduction	33.2 $\pm$ 16.0	35.6 $\pm$ 15.7	40.0 $\pm$ 14.9	45.3 $\pm$ 13.3	0.331
Lateral rotation with shoulder at 90° abduction	67.5 $\pm$ 29.7	70.5 $\pm$ 31.7	75.6 $\pm$ 19.8	82.7 $\pm$ 18.0	0.344
Lateral rotation with arm alongside the body	60.1 $\pm$ 16.6	64.8 $\pm$ 18.4	61.9 $\pm$ 15.9	65.4 $\pm$ 13.9	0.664
Extension	44.8 $\pm$ 12.5	46.9 $\pm$ 12.2	48.2 $\pm$ 8.7	54.5 $\pm$ 8.8	0.032

\* Analysis of variance for repeated measures was used.

Goniometric measurements of shoulder ROM between groups were statistically significant in abduction and extension ( $P = 0.001$  and  $0.032$ , respectively). There were no differences between groups regarding the remaining variables (Table 3).

Regarding quality of life as assessed by the SF-36, the experimental group showed a statistically significant greater improvement compared with the control group in the domains physical function, social function, emotional role limitation, and mental health ( $P = 0.044$ ,  $0.047$ ,  $0.036$ , and  $0.037$ , respectively). The groups were homogeneous in all of the domains at the beginning of the treatment (Table 4).

In the isokinetic evaluation, the only variable that showed a statistically significant difference between groups was total work parameters at a speed of  $60^\circ/\text{second}$  in the extension movement ( $P = 0.050$ ). This demonstrates that the experimental group achieved a greater improvement compared with the control group, because both groups were homogeneous at the beginning of treatment (Table 5).

The Likert scale evaluating pain revealed that the experimental group exhibited a greater number of “much better” and “a little better” responses than the control group. This difference was statistically significant between groups ( $P = 0.001$ ).

## DISCUSSION

Our objective was to investigate the effects of progressive resistance training in patients with shoulder impingement syndrome. Our study is the first to use the DeLorme method of progressive resistance training in patients with shoulder impingement syndrome (6). A number of reviews have studied progressive resistance training as a form of intervention for cardiopulmonary diseases (24,25), musculoskeletal diseases (26,27), neuromuscular diseases (28), and gerontologic diseases (24,29), demonstrating benefits for some diseases.

Regarding shoulder impingement syndrome, there are studies that have used exercises (21,30–44), but most failed to describe the exercises in a detailed manner in terms of intensity, duration, frequency, and load. In the present study, we determined such factors in a muscle strengthening program for the shoulder musculature based on progressive resistance training (8). Thus, the comparison of results with those from other studies is difficult. Our results demonstrate that there was a statistically significant improvement in pain (assessed using a visual analog scale) favoring the experimental group over the control group and demonstrating that resistance training for strengthening the musculature of the affected shoulder was effective in reducing both pain while at rest ( $P =$

**Table 4. Mean  $\pm$  SD values for Short Form 36 domains for the experimental and control groups\***

Domains	Control group		Experimental group		<i>P</i> (between groups)
	Baseline	After 2 months	Baseline	After 2 months	
Physical function	62.2 $\pm$ 20.3	62.8 $\pm$ 22.3	54.8 $\pm$ 19.8	64.3 $\pm$ 19.0	0.044
Physical role limitation	25.8 $\pm$ 36.2	30.8 $\pm$ 39.8	31.7 $\pm$ 37.1	36.7 $\pm$ 41.4	1.000
Pain	43.9 $\pm$ 19.2	46.7 $\pm$ 24.1	43.3 $\pm$ 17.3	54.3 $\pm$ 16.0	0.102
General health	70.5 $\pm$ 25.6	68.2 $\pm$ 25.3	73.4 $\pm$ 17.2	73.9 $\pm$ 20.3	0.407
Vitality	50.4 $\pm$ 25.4	49.4 $\pm$ 26.9	52.4 $\pm$ 24.1	54.8 $\pm$ 24.7	0.442
Social function	73.3 $\pm$ 29.7	65.4 $\pm$ 27.2	69.6 $\pm$ 32.3	76.7 $\pm$ 27.4	0.047
Emotional role limitation	54.4 $\pm$ 44.2	55.5 $\pm$ 42.3	40.0 $\pm$ 40.5	62.22 $\pm$ 40.8	0.036
Mental health	54.9 $\pm$ 25.1	56.5 $\pm$ 25.1	53.5 $\pm$ 24.9	62.9 $\pm$ 22.0	0.037

\* Analysis of variance for repeated measures was used.

**Table 5. Mean  $\pm$  SD peak torque (PT) and total work (TW) at a velocity of 60°/second in the control and experimental groups according to affected side\***

	Control group		Experimental group		<i>P</i> (intergroup PT)	<i>P</i> (intergroup TW)
	PT (Nm)	TW (joules)	PT (Nm)	TW (joules)		
Flexion					0.064	0.132
Initial	22.30 $\pm$ 10.70	27.60 $\pm$ 16.26	25.50 $\pm$ 12.82	32.50 $\pm$ 17.27		
Final	21.97 $\pm$ 13.46	28.23 $\pm$ 20.41	29.20 $\pm$ 11.46	37.73 $\pm$ 17.57		
Extension					0.134	0.050
Initial	30.23 $\pm$ 17.03	42.17 $\pm$ 24.63	36.63 $\pm$ 19.25	49.87 $\pm$ 28.20		
Final	28.40 $\pm$ 19.27	37.93 $\pm$ 27.29	40.03 $\pm$ 18.42	55.37 $\pm$ 29.11		
Abduction					0.121	0.101
Initial	16.63 $\pm$ 11.89	18.43 $\pm$ 16.41	22.10 $\pm$ 11.89	23.87 $\pm$ 17.68		
Final	15.80 $\pm$ 11.44	16.27 $\pm$ 16.18	24.37 $\pm$ 11.98	25.53 $\pm$ 17.78		
Adduction					0.165	0.082
Initial	21.13 $\pm$ 16.86	23.90 $\pm$ 22.38	29.20 $\pm$ 17.49	29.70 $\pm$ 24.26		
Final	21.73 $\pm$ 18.42	22.60 $\pm$ 24.63	33.80 $\pm$ 18.39	33.67 $\pm$ 25.94		
Medial rotation					0.153	0.058
Initial	16.70 $\pm$ 7.50	19.90 $\pm$ 9.50	19.83 $\pm$ 8.06	24.70 $\pm$ 11.97		
Final	17.13 $\pm$ 7.99	20.30 $\pm$ 10.68	22.23 $\pm$ 9.28	28.93 $\pm$ 13.03		
Lateral rotation					0.451	0.270
Initial	9.20 $\pm$ 3.53	10.53 $\pm$ 5.22	11.00 $\pm$ 4.95	12.73 $\pm$ 6.94		
Final	9.53 $\pm$ 4.15	12.00 $\pm$ 7.52	12.00 $\pm$ 5.12	17.37 $\pm$ 14.85		

\* Analysis of variance for repeated measures was used.

0.001) and pain during movement ( $P = 0.001$ ). Even while using a greater number of antiinflammatory drugs and analgesics than the experimental group, the control group did not have any significant improvement in pain. This finding demonstrates that the progressive resistance training program we are proposing was effective in improving patient pain and reducing the number of pain pills.

Brox et al (30) studied a population with stage II shoulder impingement syndrome using 3 different therapies: exercises, surgery, and placebo laser. The authors found more improvements regarding pain in the group that performed exercise training and the group that underwent surgery compared with the control group; there was no difference between the 2 intervention groups. In the followup of these patients after 2.5 years, Brox et al (36) concluded that both intervention groups continued to demonstrate a greater improvement compared with the control group, and there continued to be no differences between the patients treated with surgery and those treated with exercise. The exercise program proposed by Brox et al (30) included strengthening exercises supervised by a physiotherapist and performed twice a week for a period of 3–6 months. However, there was no description of how the progressive resistance was calculated.

Ginn et al (31) reported improvements in function and ROM with pain-free abduction and flexion among patients with nonspecific shoulder pain, regardless of etiology. Individualized treatment was carried out with strengthening, stretching, and scapulohumeral rhythm exercises. There was no improvement in pain (assessed using a visual analog scale) between the exercise group and control group. However, there was an improvement in the abduction ROM in the group that underwent exercise training. The results from our study revealed an improvement in pain, thereby differing from the results of the study by

Ginn et al (31) while corroborating the results of other studies (21,32,33,45). Our study also found improvement with regard to the abduction ROM in the group treated with exercise when compared with the control group, which is in agreement with other studies (31,45). This demonstrates that such movement is considerably compromised in shoulder injuries and can be improved with exercise.

Wang and Trudelle-Jackson (45) isometrically assessed strength and found a difference between groups with exercise, thereby differing from the results of Ginn et al (31), who found no difference in the assessment of isometric strength. In the present study, the assessment of muscle strength was performed using an isokinetic dynamometer. We only observed a statistically significant improvement in total work during the extension movement of the experimental group in comparison with the control group. No experimental intervention study was found in the literature that used isokinetic assessment of shoulder muscle strength in patients with shoulder impingement syndrome who had participated in an exercise program for rehabilitation. Perhaps if we had used the 6 RM calculation based on the principle of specificity, we would have found different results in the isokinetic evaluation.

Rahme et al (34) compared one group that underwent acromioplasty and another that underwent an exercise and education program. The authors concluded that there was an improvement regarding pain in the patients with shoulder impingement syndrome who underwent surgery. However, there was no comparison between groups at the beginning of treatment and there were a number of cointerventions with no intent-to-treat analysis. With such methodologic problems, it becomes impossible to compare the results from that study with those from the present study.

Other studies found no improvement in function among patients with shoulder injuries treated with exercise, including those with shoulder impingement syndrome (33,35,39,41). In the present study, patients from the experimental group showed greater improvement regarding function (assessed by the DASH) compared with those from the control group. In the optional DASH 2 module, which addresses work activities, the improvement was 42%, whereas improvement was 24% in the DASH 3, when compared with the beginning of treatment. Other studies have also found improvement in the function of patients who participated in exercise programs (31,32,37,38,41,43,45,46), but none of these studies used the DASH as a tool for assessing shoulder function. In the present study, we used concentric as well as eccentric exercises, but did not find a significant improvement in shoulder strength, possibly due to the short period of time, as explained above. The improvement in function may be related to an improvement regarding pain. One explanation is that when there are limitations in the performance of activities, patients with shoulder pain find ways to adapt, which may lead to a better result in terms of functional activity.

The improvement in pain in the patients from the experimental group in the present study was a statistically significant as well as clinically important finding, as there was an improvement of 1.8 points (42%) in pain while at rest and 2.2 points (30%) in pain during movement when compared with the beginning of treatment. This improvement may have occurred due to scapulohumeral stability (47). Impact occurs on the anterior margin and two-thirds below the anterior surface of the acromion, as well as on the coracoacromial ligament; at times the acromioclavicular may be involved as well. The acromion process is not the only etiologic factor in shoulder impingement syndrome (48); other factors such as instability, rotator cuff fatigue, and contraction of the posterior capsule may be the cause of injury (49). Exercises for strengthening the muscles of the rotator cuff stabilize the shoulder joint, thereby promoting a medial adjustment below the head of the humerus (3). The aim of the training program in the present study was to strengthen the musculature of the rotator cuff, thereby promoting stability in the joint, which is likely to have been one of the factors that led to the improvement of pain.

The patients treated with progressive resistance training exhibited improvements in comparison with the control group regarding some domains of the SF-36, such as physical function, social function, emotional role limitation, and mental health. We found one study that assessed quality of life among patients with shoulder impingement syndrome treated with exercise (50). The authors studied 39 patients with shoulder impingement syndrome who participated in a program of strengthening exercises for the musculature of the shoulder. The patients showed improvement with regard to pain, function, ROM, and physical role limitations of the SF-36. This result differs from our study, as we found no difference in the physical aspect between the groups studied. However, the McClure et al study (50) had no randomization or control group; all of the patients participated in the treatment and the compar-

ison parameter was the initial assessment. In addition, >20% of the patients were lost.

In the present report, we describe in detail the type, load, intensity, and frequency of the exercises. We calculated the 6 RM, we stipulated the percentage to be worked, and we recalculated the load every 2 weeks. This type of description is lacking in most articles on the use of exercise. As such, it becomes difficult to reproduce what has been tested. Moreover, we found that the patients who participated in the experimental group exhibited a much higher degree of satisfaction than those in the control group. This difference was statistically significant ( $P = 0.001$ ), as 27 patients reported feeling better than when they began the treatment. The patients in the control group were instructed not to undergo any type of physical intervention for the shoulder, and only to use medication when necessary. One limitation of the study was the use of a control group without any physical intervention. The control patients maintained their medication use and were placed on a waiting list for exercise therapy. There was no way for us to prescribe any exercise that would not produce any effect, because even the smallest amount of exercise could have influenced the results. Therefore, we found it prudent not to contaminate the control group with any physical intervention.

We conclude that the patients who underwent progressive resistance training exhibited improvements regarding pain and function (evaluated by the DASH) in comparison with the control group. There was marked improvement regarding total work in the extension movement as well as in the following domains of the SF-36: physical function, emotional role limitations, and mental health. There was no improvement in muscle strength among the patients treated, despite the clinical improvement.

#### AUTHOR CONTRIBUTIONS

Dr. Natour had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Study design.** Lombardi, Natour.

**Acquisition of data.** Lombardi, Magri, Fleury, da Silva, Natour.

**Analysis and interpretation of data.** Lombardi, Natour.

**Manuscript preparation.** Lombardi, Natour.

**Statistical analysis.** Lombardi, Natour.

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