

# REASSESSMENT OF PAINFUL SHOULDERS AMONG BASEBALL PLAYERS AFTER CONSERVATIVE TREATMENT

Alberto Naoki Miyazaki<sup>1</sup>, Marcelo Fregoneze<sup>2</sup>, Pedro Doneux Santos<sup>3</sup>, Luciana Andrade da Silva<sup>3</sup>, Guilherme do Val Sella<sup>3</sup>, Fábio Eduardo Ishioka<sup>4</sup>, João Roberto Polydoro Rosa<sup>4</sup>, José Renato Depari Estelles<sup>5</sup>, Sérgio Luiz Checchia<sup>6</sup>

## ABSTRACT

**Objective:** The objective of this study was to evaluate the rehabilitation results among baseball players who presented pain and medial rotation deficit in their shoulders. **Methods:** Out of 55 baseball players assessed between April and June 2009, it was observed that 20 presented pain at some instant during throwing movements. They were advised to undergo a rehabilitation program with exercises to stretch the posterior capsule and reinforce the muscles of the scapular belt, especially the lateral rotators. Eighteen patients followed the advice, while two were lost from the follow-up. The parameters evaluated were: pain, range of motion, strength before the program and strength after the end of the program. **Results:** Comparing the initial and final assessments, we observed mean increases as

follows: 10° of elevation ( $p = 0.001$ ); three vertebral levels of medial rotation ( $p < 0.001$ ); 20° of medial rotation at 90° abduction ( $p < 0.001$ ); and 26° of range of motion ( $p < 0.001$ ). Regarding strength, elevation force increased by 3 kgf ( $p = 0.002$ ) and lateral rotation force increased by 1 kgf ( $p = 0.020$ ). Out of the 18 baseball players studied, the pain level improved in 16, while two continued to present pain and underwent magnetic resonance imaging, which showed lesions for surgical treatment. **Conclusion:** The rehabilitation program conducted among the baseball players was effective and enabled increases in medial rotation, elevation, range of motion and strength of elevation and lateral rotation, consequently producing pain improvements in most of the players.

**Keywords** – Baseball; Shoulder; Joint Range of Motion

## INTRODUCTION

Baseball players' throwing shoulders are subjected to overloads that may cause anatomical and/or functional alterations. Among these, decreased medial rotation (MR) of the shoulder and increased lateral rotation (LR) are observed<sup>(1-7)</sup>.

The decrease in shoulder MR among these sports players, which occurs because of contraction of the posterior capsule, may have posteroinferior and subacromial impacts and may cause muscle imbalance. It has the consequence that lesions appear in the rotator

cuff and glenoid labrum, thereby causing pain and functional impotence<sup>(1,8-11)</sup>.

Studies have shown that, to prevent and treat these alterations, baseball players should do exercises to stretch the posterior capsule, which leads to a gain in range of motion, particularly regarding MR, and should undergo a strengthening program to rebalance the muscle forces of the scapular belt<sup>(7,12-18)</sup>.

Wilk et al<sup>(7)</sup> and Lintner et al<sup>(18)</sup> applied a rehabilitation protocol subdivided into four phases, to sports players who performed throwing actions, with the aim

1 – Assistant Professor and Head of the Shoulder and Elbow Surgery Group, Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo, São Paulo, SP, Brazil.

2 – Assistant Professor and Attending Physician in the Shoulder and Elbow Surgery Group, Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo, São Paulo, SP, Brazil.

3 – Attending Physician in the Shoulder and Elbow Surgery Group, Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo, São Paulo, SP, Brazil.

4 – Trainee in the Shoulder and Elbow Surgery Group, Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo, São Paulo, SP, Brazil.

5 – Resident Physician in the Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo, São Paulo, SP, Brazil.

6 – Adjunct Professor; Academic Consultant and Member of the Shoulder and Elbow Surgery Group, Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo, São Paulo, SP, Brazil.

Work performed in the Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo (DOT-FCMSCSP), "Fernandinho Simonsen" Wing (Director: Prof. Dr. Osmar Avanzi), São Paulo, SP, Brazil.

Correspondence: Rua Dr. Cesário Mota Jr. 112, Vila Buarque, 01221-020 São Paulo, SP. E-mail: ombro@ombro.med.br.

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of achieving complete recovery of the shoulder. They also developed other programs aimed at dealing with specific lesions.

Miyazaki et al<sup>(19)</sup> conducted a study involving baseball players aged 15 years or over, in which they demonstrated statistically significant correlations between pain and altered range of motion; and between length of time practicing the sport and situations of “shoulder at risk”. Such situations were described by Burkhart and Morgan<sup>(20)</sup> as the ratio between the deficit in MR deficit (DMR) and the gain in LR gain (GLR), which shows the imbalance in shoulder adaptations that lead to the appearance of pain and lesions.

The aim of the present study was to assess the rehabilitation results among the baseball players previously studied by Miyazaki et al<sup>(19)</sup>, who presented diminished MR of the dominant shoulder, associated with pain.

**MATERIALS AND METHODS**

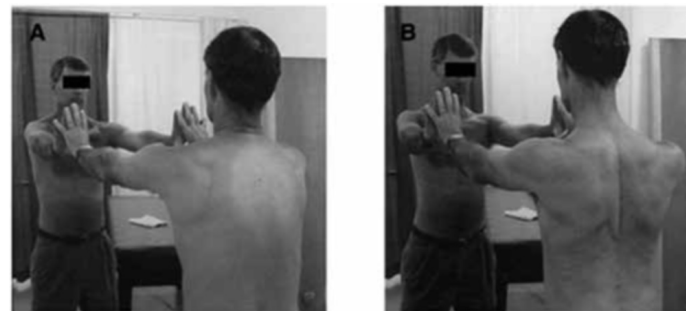
In the first study, the Shoulder and Elbow Group of the Department of Orthopedics and Traumatology, School of Medical Sciences, Santa Casa de São Paulo, evaluated 55 baseball players between April and June 2009. In that study, it was observed that 20 of them presented pain at some moment during the throwing action. They were advised to undergo a rehabilitation program with exercises to stretch the posterior capsule and reinforce the muscles of the scapular belt (assessment 1) (Figures 1A, 1B, 2A and 2B). Among these 20 players, it was seen that two stopped playing the sport due to personal problems. Thus, these two were excluded from the study, and 18 players participated in the rehabilitation program.

Baseball players aged 15 years or over were included. They needed to have a minimum training frequency of twice a week without any interruptions greater than one month over the preceding six months, along with not presenting any type of lesion diagnosed in the shoulders.

The 18 players who were followed up were male, with a mean age of 21 years (range: 15 to 29 years). Regarding the dominant arm, 17 (94%) were right-handed and one (6%) was left-handed. The mean length of time for which they had been playing baseball was nine years (range: 2 to 23 years), with a mean of three training sessions per week. Among these 18 players, four (22%) were pitchers and 14 (78%) played in other positions (Table 1).



**Figure 1** – Baseball player performing stretching of the posterior capsule, standing up (A) and in lateral decubitus (B): twice a day, with five repetitions of 30 seconds each.



**Figure 2** – Baseball player performing one of the strengthening exercises, with protraction (A) and retraction (B) of the scapulas: once a day, with three series of 15 repetitions.

**Table 1** – Results relating to pain improvement.

Patient	Age	Position	ΔT practice (years)	Pain improvement Assessment 2	Pain improvement Assessment 3
1	23	Pitcher	13	-	-
2	23	Catcher	4	-	+
3	20	Catcher r	10	+	+
4	15	Catcher	9	+	+
5	22	First base	11	+	+
6	19	Shortstop	14	+	+
7	19	Pitcher	12	-	-
8	21	Pitcher	10	+	+
9	15	Fielder	8	+	+
10	29	Catcher	23	+	+
11	20	Fielder	14	+	+
12	23	Shortstop	5	+	+
13	26	Fielder	2	+	+
14	20	Shortstop	15	+	+
15	15	Fielder	4	+	+
16	22	Pitcher	6	+	+
17	21	Second base	12	+	+
18	20	Third base	2	+	+

Source: Medical archives of Irmandade Santa Casa de Misericórdia de São Paulo. Legend: ΔT = length of time.

Regarding joint mobility, elevation, LR and MR were evaluated in accordance with the guidance of the American Shoulder and Elbow Surgeons (ASES). Following this, LR and MR were also measured with the patient in a supine position with the shoulder abducted at 90°, the elbow flexed at 90° and the forearm in neutral rotation, in accordance with the parameters described by Hawkins and Bokos<sup>(21)</sup> and Donatelli et al<sup>(22)</sup> (LR90 and MR90).

All the measurements were made with a graduated goniometer, and the non-dominant shoulder was used as a parameter to calculate possible gains or losses of range of motion, and differences in elevation strength and LR.

The arc of rotation (AR) was calculated by summing the LR90 and MR90 values. The GLR was measured as the difference in LR90 between the dominant and non-dominant shoulders. The DMR was calculated as the different in MR90 between the dominant and non-dominant shoulders. The ratio between the DMR and GLR was calculated to ascertain which baseball players presented a “shoulder at risk”, i.e. those for whom the value of this ratio was less than one, as described by Burkhart and Morgan<sup>(20)</sup>.

The isometric contraction force was measured using a manual dynamometer (KERN® CH 50K50), which was calibrated in accordance with the manufacturer’s specifications. The measurements were made in the movement planes recommended by ASES and by Hawkins and Bokos<sup>(21)</sup> and Donatelli et al<sup>(22)</sup>.

To prevent compensatory muscle action in the measurements, a vertical resistance force was applied to the arm evaluated, and the joint was kept at an appropriate angle. Three maximum-force measurements were made along each axis evaluated, and the value of the maximum force was noted in kilograms force (kgf), for each of them. The mean for the three repetitions was determined for each axis. The contralateral shoulder was evaluated in the same way.

After nine months of guidance through the rehabilitation program, a new assessment was made on each of the 18 baseball players (assessment 2). They were also asked about their adherence (or non-adherence) to this program, and a check was made on how they were doing the exercises, so that errors in implementing the rehabilitation could be avoided.

From this time onwards, the players were asked every month about their physiotherapy and state of

pain. Three months later, the final assessment was made (assessment 3).

All the data relating to pain, joint mobility, muscle strength, “shoulder at risk” and rehabilitation were compiled and statistically analyzed using the SPSS software (Statistical Package for the Social Sciences), version 17.0; p-values  $\leq 0.050$  (5%) were taken to be significant. This study was approved by the Ethics Committee for Research on Human Beings of Santa Casa de Misericórdia de São Paulo.

## RESULTS

Nine months after assessment 1 (i.e. at assessment 2), we observed that out of the 18 baseball players, 15 had achieved an improvement in their pain. Four players had done the complete rehabilitation program, 13 only did stretching exercises and one did not follow the program.

At the final assessment, one year after assessment 1 (i.e. at assessment 3), only two of the players continued to present pain. Fourteen had been doing all the exercises and four had only been doing the stretching (Table 1).

At assessment 2, it was found that there was a deficit of joint mobility on the dominant side, in relation to the contralateral limb, with increased LR90 ( $p = 0.001$ ) and deficits in MR ( $p = 0.001$ ) and MR90 ( $p = 0.018$ ), which were considered to be statistically significant.

At assessment 3, the results were similar to those at assessment 2, but with statistically significant differences in relation to increased LR90 ( $p < 0.001$ ) and diminished MR ( $p = 0.003$ ) and MR90 ( $p = 0.009$ ). There was an increase in AR ( $p = 0.001$ ). All 18 patients showed improvements in mobility and strength (Table 2).

From analysis on muscle strength on the dominant and contralateral sides at assessment 2, statistically significant differences in elevation ( $p = 0.021$ ) and LR90 ( $p = 0.031$ ) could be seen, with gains in muscle strength in the dominant limb.

Also in relation to muscle strength, in assessment 2 alone there was a statistically significant gain in LR, in comparing the baseball players who had done all the exercises with those who had only done stretching ( $p = 0.020$ ).

In comparing assessment 3 with assessment 1 in relation to joint mobility, we obtained statistically significant results: regarding mean elevation, there

**Table 2 – Mobility results**

N	Assessment 1									Assessment 2									Assessment 3								
	Elev	LR	LR90°	MR	MR90°	AR	GLR	DMR	SR	Elev	LR	LR90°	MR	MR90°	AR	GLR	DMR	SR	Elev	LR	LR90°	MR	MR90°	AR	GLR	DMR	SR
1	155	70	90	T11	50	140	10	30	+	160	90	122	T8	70	192	32	20	-	170	80	125	T7	70	195	35	20	-
2	155	80	100	T12	80	180	0	10	Ø	160	85	120	T8	80	200	20	10	-	170	80	120	T7	90	210	20	0	-
3	170	80	140	T7	70	210	5	20	+	170	90	120	T6	80	200	10	0	-	170	80	135	T5	90	225	15	0	-
4	140	75	110	T10	50	160	20	25	+	140	75	110	T8	75	185	0	15	Ø	170	90	120	T6	90	210	10	0	-
5	170	80	110	T7	70	180	-20	10	-	170	90	130	T6	90	220	20	0	-	170	80	130	T5	90	220	20	0	-
6	160	80	120	T8	70	190	-10	10	-	170	90	140	T7	90	230	10	0	-	170	70	120	T6	90	210	30	0	-
7	170	90	120	T10	60	180	0	10	Ø	170	90	120	T7	80	200	0	10	Ø	170	90	100	T7	90	190	0	0	Ø
8	160	80	130	T10	70	200	10	10	-	160	90	130	T8	70	200	20	10	-	170	90	130	T8	80	210	40	10	-
9	160	90	130	T8	80	210	20	10	-	160	90	130	T7	70	200	30	5	-	170	90	130	T6	90	220	40	0	-
10	160	90	100	T10	60	160	-10	20	-	160	80	100	T8	70	170	10	15	+	160	90	100	T7	80	180	10	0	-
11	160	70	120	T11	60	180	0	20	Ø	160	80	120	T10	60	180	0	20	Ø	170	70	100	T8	70	170	10	20	+
12	170	90	130	T6	50	180	10	30	+	160	90	120	T5	75	195	10	5	-	170	90	125	T4	80	205	35	10	-
13	160	90	110	T11	70	180	0	10	Ø	160	90	100	T10	80	180	10	-20	-	170	90	120	T8	90	210	0	10	Ø
14	150	80	120	T10	50	170	-10	0	-	160	75	120	T10	60	180	20	0	-	170	80	120	T8	70	190	20	20	-
15	140	90	100	T4	70	170	10	0	-	150	90	120	T3	75	195	30	15	-	170	90	140	T3	80	220	40	10	-
16	155	80	90	T7	70	160	0	20	Ø	160	70	130	T7	80	210	20	10	-	170	80	130	T6	80	210	40	10	-
17	160	90	140	T8	40	180	20	30	+	170	90	130	T7	80	210	10	10	-	170	90	130	T6	90	220	30	0	-
18	160	80	110	T7	80	190	-10	10	-	170	90	120	T6	90	210	0	0	-	170	90	120	T5	90	210	10	0	-

Source: Medical archives of Irmandade Santa Casa de Misericórdia de São Paulo. Legend: Elev = elevation; LR = lateral rotation; MR = medial rotation; T = thoracic vertebra; L = lumbar vertebra; AR = arc of rotation; GLR = gain in lateral rotation; DMR = deficit in medial rotation; SR = shoulder at risk; Ø = impossible to calculate.

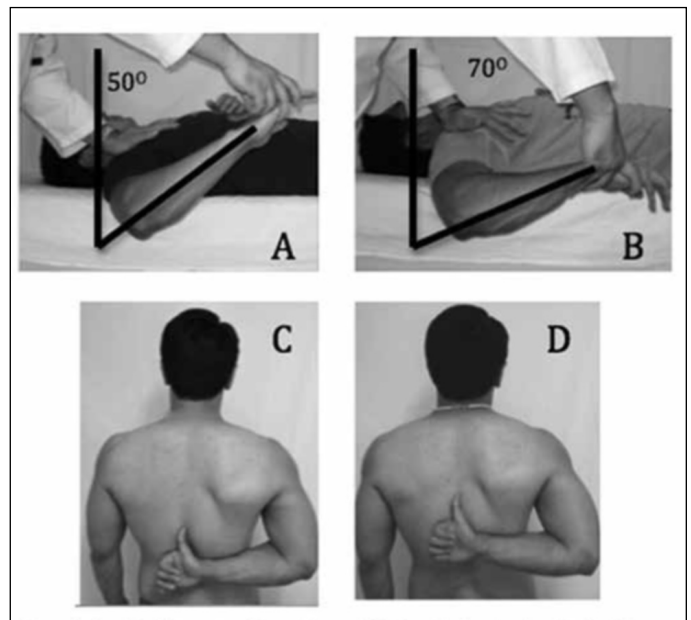
was an increase of 10° (p = 0.001); regarding MR, an increase of three vertebral levels (p < 0.001); regarding MR90, an increase of 20° (p < 0.001); and regarding AR, an increase of 26° (p < 0.001) (Figures 3 A-D, 4 and 5).

In relation to muscle strength, an improvement in elevation strength was evident, with an increase of 3 kgf (p = 0.002). There was also an increase in LR strength, of 1 kgf (p = 0.020) (Figure 6) (Table 3).

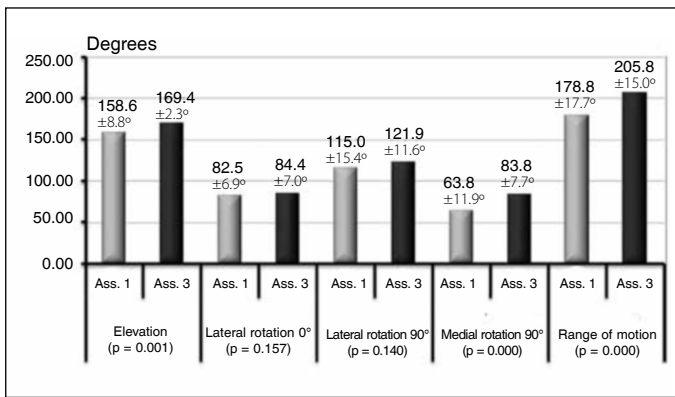
The relationships of joint mobility, muscle strength and situation of “shoulder at risk” between the baseball players with and without pain did not show statistical correlations in any of the measurement planes at any of the assessments.

**DISCUSSION**

Baseball players’ shoulders are subjected to extreme forces during the throwing action. Through this, this joint may develop a gain in LR and diminished MR<sup>(18,23)</sup>. These alterations were also found in the study by Miyazaki et al<sup>(19)</sup>.

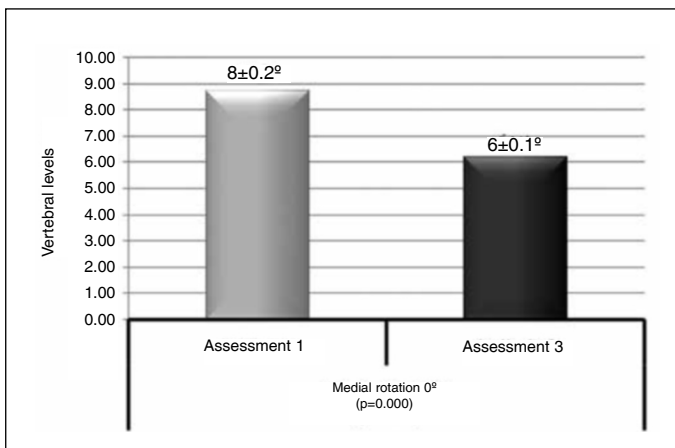


**Figure 3 – Case 2: baseball player in supine position with right shoulder abduction of 90° and elbow flexion of 90°: (A) with MR90 of 50° at assessment 1; (B) gain of 20° at assessment 3; (C) assessment 1 on the same player, with the limb in shoulder abduction of 20° and vertebral level T11; (D) gain of four vertebral levels at assessment 3, reaching vertebral level T7.**



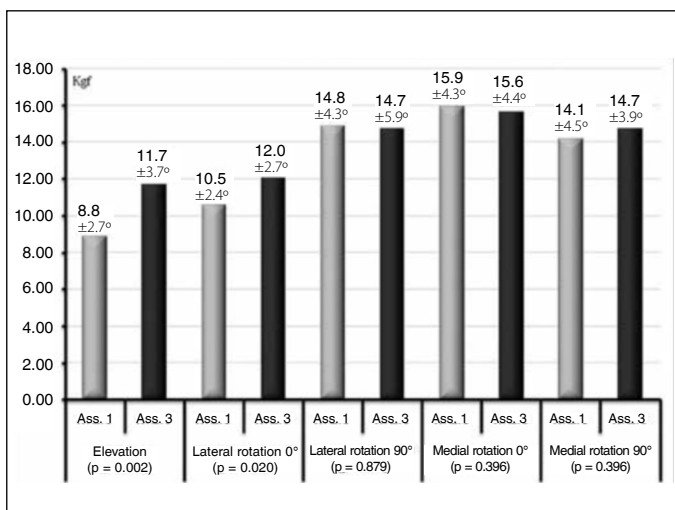
**Figure 4** – Comparison of mobility of the affected shoulder between assessments 1 and 3, in degrees. It was seen that there were statistically significant differences in relation to elevation, AR and MR90.

Source: Medical archives of the hospital. Legend: Ass. 1 = assessment 1; Ass. 3 = assessment 3; \* = standard deviation.



**Figure 5** – Comparison of mean mobility of medial rotation (MR) of the affected shoulder between assessments 1 and 3, measured in vertebral levels. A statistically significant difference was seen.

Source: Medical archives of the hospital. Legend: \* = standard deviation



**Figure 6** – Comparison of the strength of the affected shoulder between assessments 1 and 3, in kgf. It was seen that there were statistically significant differences in elevation strength and lateral rotation (LR).

Source: Medical archives of the hospital. Legend: Ass. 1 = assessment 1; Ass. 3 = assessment 3; \* = standard deviation.

According to Burkhart et al<sup>(8)</sup>, it was observed that shoulder lesions may occur if the AR values are less than 180° and the MR deficit is greater than 25°. In assessment 1, we observed that the 18 baseball players with pain during throwing actions had deficits of elevation and MR and a mean AR of 179°. For this reason, they were referred for physiotherapy, with the aim of recovering their MR.

If contracture of the posture capsule is considered to be the cause of the deficit in MR, and the latter as one of the factors responsible for shoulder lesions, appropriate stretching of the posterior capsule and correction of this deficit should prevent the lesions<sup>(1,6,7)</sup>. Our rehabilitation program led to a significant improvement in pain, probably because we achieved gains in MR, MR90 and AR of 26° on average, thus reaching 205°. However, despite the improvement in AR, we noted that a difference in AR between the dominant and contralateral arms was maintained, even after the rehabilitation program. We believe that the gain was sufficient to diminish the risk of shoulder lesion, because the players experienced reductions in pain.

Several studies relating to exercise programs for professional baseball players have demonstrated gains in MR and MR90. In some of them, this gain was immediate, after the stretching exercise, but did not last. In others, like the study by Lintner et al<sup>(18)</sup>, the gain was progressive and became more significant after two years of exercises<sup>(13-15,24)</sup>. Our program showed progressive and long-lasting gains, i.e. the players maintained or increased the gain in movement up to the end of the rehabilitation.

In relation to muscle strength, Wilk et al<sup>(24)</sup> demonstrated through isokinetic tests that the LR strength of the dominant shoulder of throwers is significantly lower than that of the contralateral shoulder. In compensation, the MR strength is greater in the dominant shoulder than in the contralateral shoulder. They also demonstrated that when the LR muscle strength reached at least 65% of the MR muscle strength of the same limb, there was a state of balance between the agonist and antagonist muscles of the shoulder. Byram et al<sup>(25)</sup> evaluated the LR muscle strength of professional baseball players during the preseason period and noted that those with weakness of the lateral rotators had a greater number of lesions during the season. At assessment 2, we saw that the players

**Table 3** – Strength results in kgf.

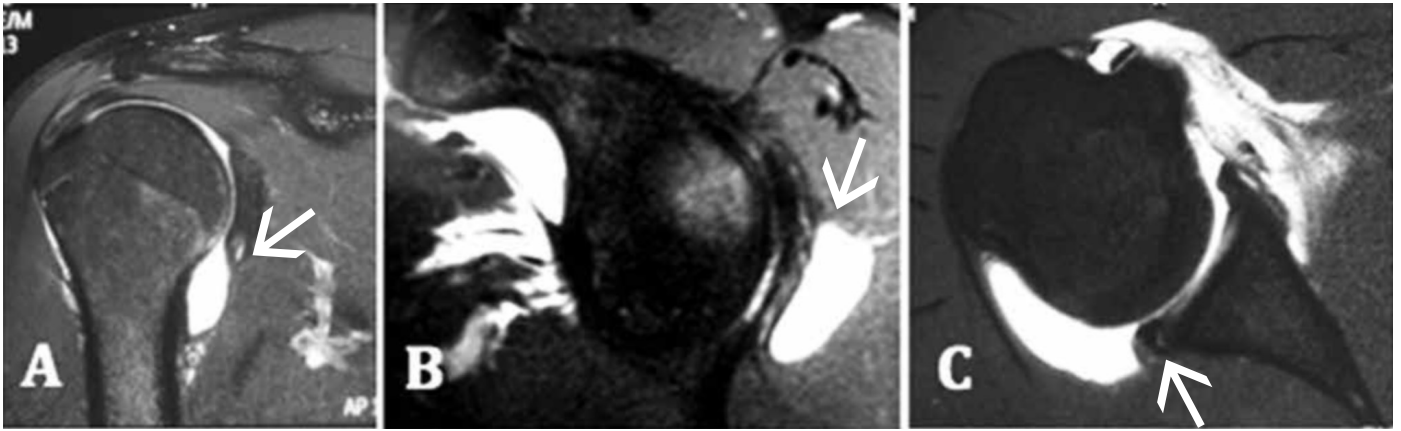
N	Assessment 1					Assessment 2					Assessment 3				
	Elev	LR	LR90°	MR	MR90°	Elev	LR	LR90°	MR	MR90°	Elev	LR	LR90°	MR	MR90°
1	3.88	7.16	9.21	17.20	11.56	3.66	8.15	8.06	17.78	15.10	3.11	10.55	4.78	13.21	11.38
2	11.70	15.18	11.63	15.31	14.41	11.35	9.45	9.45	10.93	14.95	10.88	13.21	7.51	15.75	17.66
3	7.86	10.38	16.55	20.51	18.40	12.23	12.26	22.35	22.23	18.41	10.46	13.10	17.81	17.56	15.85
4	8.61	11.11	17.15	18.83	18.00	8.41	10.78	17.66	19.01	18.31	11.00	11.13	10.78	14.96	11.78
5	11.90	10.30	16.91	20.96	16.76	13.83	14.38	22.06	25.60	18.63	14.25	11.55	18.33	17.45	13.40
6	14.48	12.10	21.08	18.33	15.31	18.00	13.56	20.66	17.10	16.05	15.31	12.28	14.66	15.01	16.05
7	12.26	14.46	21.66	17.60	12.95	18.51	14.38	18.25	13.75	18.88	13.86	13.26	17.78	16.53	16.60
8	5.53	7.76	10.38	12.98	9.45	8.98	10.16	11.18	15.08	12.10	12.55	9.63	11.81	15.90	13.60
9	7.00	8.43	15.58	9.43	17.98	7.93	8.79	15.95	10.25	17.65	13.86	11.26	16.23	12.56	20.31
10	9.63	13.28	21.65	27.05	22.16	14.23	16.70	29.88	27.46	25.43	15.13	17.13	31.20	29.13	25.63
11	7.40	11.36	7.50	14.70	10.63	13.26	15.41	21.65	22.10	19.98	10.78	10.41	9.65	13.00	12.65
12	7.08	12.06	14.39	15.00	22.30	9.78	10.23	15.15	14.28	13.51	12.55	12.05	15.90	17.36	14.78
13	7.41	8.91	14.13	14.38	11.83	6.95	14.65	10.83	12.23	8.51	9.60	9.61	14.28	10.63	12.05
14	9.45	11.11	18.75	13.23	7.50	10.33	15.06	17.51	20.80	14.98	16.56	18.20	16.33	21.03	13.60
15	5.31	5.83	10.80	10.20	6.23	6.43	5.95	10.86	10.41	6.95	6.26	7.08	11.38	9.85	10.66
16	10.16	8.70	10.45	10.08	11.16	10.85	10.91	14.25	11.30	13.76	6.81	9.41	13.80	9.73	11.88
17	10.20	11.48	13.20	14.35	12.91	10.65	11.33	12.56	12.45	12.00	10.21	11.15	9.88	14.33	9.31
18	9.28	10.61	16.03	16.16	15.23	16.85	14.71	22.15	15.56	16.68	17.43	15.13	22.46	16.76	17.56

Source: Medical archives of Irmandade Santa Casa de Misericórdia de São Paulo. Legend: Elev = elevation; LR = lateral rotation; MR = medial rotation.

had predominantly been doing stretching exercises and not strengthening exercises. We advised our baseball players regarding the importance of doing the entire rehabilitation program. At assessment 3, greater adherence to the exercises was noted, and there were gains in AR, LR and elevation muscle strength.

Our study showed at assessment 1 that the LR strength of the dominant shoulder reached 67% of the MR strength. However, at assessment 2, we saw that there had been an improvement in the balance between the muscle strengths, with 72%, and at assessment 3, with 76%. These gains were analyzed and were found to present statistical significance, comparing evaluations 1 and 3, thus showing that the baseball players' shoulders presented an adequate response to the physiotherapy.

Two of the players did not achieve improvements in pain, which led us to investigate the possibility of anatomical injuries developed during sports practice. Burkhart and Morgan<sup>(20)</sup> also reported that a deficit in MR causes abnormal mobility of the humeral head in the posterosuperior direction, thus resulting in a lesion in the posterosuperior labrum and lesions in the joint portion of the supraspinatus tendon. Magnetic resonance examinations on these two players showed that player no. 7 had a lesion in the posterosuperior labrum, while player no. 1 had a lesion in the posteroinferior labrum. These individuals are undergoing outpatient follow-up, but one of them stopped complaining of pain after stopping his sports activities, and did not wish to continue with the treatment (Figure 7A-C).



**Figure 7** – Case 1: Magnetic arthro-resonance images of the right shoulder of a baseball player who did not achieve improvement of his pain through the rehabilitation program: (A) T2 coronal slice showing lesion of the posteroinferior labrum (arrow); (B) T2 sagittal slice showing posteroinferior paralabral cyst associated with lesion of the posteroinferior labrum (arrow); (C) T2 axial slice showing posteroinferior detachment of labrum (arrow).

## CONCLUSION

The rehabilitation program applied to the baseball players was effective and enabled increases in MR, elevation, AR, elevation muscle strength and LR, with

consequent improvement of pain. A mean gain in AR of  $26^\circ$  was enough to improve the shoulder pain of these baseball players.

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