SHOULDERS OF PATIENTS WITH SPINAL CORD INJURIES SUBMITTED TO REHABILITATION PROGRAM - A CLINICAL AND ULTRASOUND-BASED ASSESSMENT

ANDRÉ FELIPE NINOMYIA[1], CAROLINA LUÍSA MARTINS DE JESUS[1] , LEANDRO LUIS AULETTA[2], CAROLINA DE MEDEIROS RIMKUS[2], DANIEL MIRANDA FERREIRA[3], AMÉRICO ZOPPI FILHO[4], ALBERTO CLIQUET JUNIOR[5]

SUMMARY

The increasing incidence of high energy traumas is associated to a growing prevalence of spinal cord injuries causing motor sequels on limbs. Rehabilitation programs provide an opportunity for improvement of quality of life, helping on integrating those individuals back into social activities. Shoulder pain is more frequent in individuals with spinal cord injury, regardless of the rehabilitation program adopted. In the current study, 32 shoulders of 16 patients with spinal cord injury levels between C4 and T12 submitted to a rehabilitation program at DOT/UNICAMP were evaluated by using ultrasound. Changes on rotator cuff tendons were detected in 56.25%, and 12.50% of the patients presented changes in humeral tuberosities. These changes were more prevalent in quadriplegic patients. Analgesic therapies, rotator cuff muscles' strengthening whenever possible, and postural rehabilitation may provide shoulder pain reduction, enhancing the advantages of rehabilitation programs and providing a better quality of life.

Keywords: Shoulder; Shoulder; Shoulder pain; Ultrasound; Spinal cord traumas.

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INTRODUCTION

The increasing number of automobile accidents associated to increasing levels of violence in urban areas of capital and metropolitan cities has led to an increased incidence of trauma in the population in general.

Considering the population affected by trauma, 8.6% of the patients admitted in university hospitals in Brazil diagnosed with orthopaedic injuries present with a rachimedullary trauma (RMT)[1]. Other etiologies of RMT are high falls and trauma during sports practice, with emphasis to shallow water diving.

Regarding topographic location, 55% are on cervical spine, 15% on the thoracic-lumbar region, and other 15% on lumbossacral region. The most commonly found fracture is at C5, and the most frequent fracture-dislocation is at C5-C6 level.[2]

Among these patients, about 68.00%(1) evolve with some degree of neurological injury associated or not to sensitive-motor sequel (paraplegia or quadriplegia).

The inclusion in a rehabilitation program means more than a possibility of neurological deficit regression; it is also related to a perspective of improving activities of daily life, a reduced level of dependence on caregivers, to the improvement of sociability, to the reduction of clinical co-morbidities resulting from long in-bed periods and, finally, to a significant improvement of these people's quality of life.

At the Rehabilitation Service of the Department of Orthopaedics and Traumatology, Hospital de Clínicas, Campinas State University (DOT/ HC-UNICAMP), the proposal of a rehabilitation plan initially considers the level of spinal cord injury, with patients presenting injuries distal to T2, paraplegic, start locomotion with the aid of a wheelchair, a pair of crutches or walker. Patients with injuries between C4 and T1 level, quadriplegic, may move with a wheelchair or be rehabilitated on slipstreams with the aid of hangers.

During drills, whether on a wheelchair, slipstream or using a pair of crutches or walkers (Figure 1), the patients usually experience shoulder pain with symptoms and physical examination consistent to rotator cuff tendinopathy (tendons of muscles supraspinal, infraspinal, subscapular and minor round) either associated or not to shoulder osteoarthritis.

In addition to pain complaints related to the rehabilitation program, shoulder complaints are known to be potentially present regardless of the physiotherapeutic activity. According to Sie[3] and Silfverskiold[4], 51% of the patients with spinal cord injuries present omalgic complaints, more prevalent in quadriplegic than in paraplegic patients. Complaints, as well as shoulder injuries, present a bimodal distribution: from trauma to a six-month period after injury, 78% of the quadriplegic and 35% of the paraplegic patients present with complaints associated or not to anatomical injury of the shoulder. These values drop to 33% and 10%, respectively, between the sixth

Study conducted at the Department of Orthopaedics and Traumatology, Medical Sciences College, Campinas State University - UNICAMP.

Correspondences to: Carolina Luísa Martins de Jesus – Rua: Arquiteto José Augusto Silva, 761, apto. 51 – Edifício Tobago, Parque Santa Cândida, Campinas, São Paulo, Brasil – CEP: 13087-570 – carolina_unicamp@hotmail.com

1- Resident Doctor, Department of Orthopaedics and Traumatology, UNICAMP.
2- Resident Doctor, Department of Orthopaedics and Traumatology, UNICAMP
3- Resident Doctor, Department of Radiology, UNICAMP.
4- Contracted Doctor, Department of Radiology, UNICAMP.
5- Volunteer Professor, Department of Orthopaedics and Traumatology, UNICAMP.
6- Chairman, Department of Orthopaedics and Traumatology, UNICAMP.

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and the eighteenth subsequent months [4]. Literature shows an increase of these numbers after 20 years of injury[5].
Among the several hypotheses about the etiology of omalgia, the greater use of upper limbs for activities of daily life (locomotion, transfer from chair to bed, seated position maintenance), as well as activities such as sports practice, are believed to cause an excessive use of joint, which is responsible for the genesis of the algic process[6,-13].
This finding, as well as the investigation of such complaints, has been poorly mentioned by literature, motivating investigation by means of imaging methods of the Shoulder Painful Syndromes presented by patients with spinal cord injuries. By this, we intend to evidence the most frequent injuries in that group of patients, enabling to suggest measures for avoiding or reducing the incidence of diseases in these individuals' shoulders, and to propose treatment options, targeting a better use of the rehabilitation program and enhanced quality of life.

MATERIAL AND METHOD

Thirty-two shoulders of 16 patients with spinal cord injury secondary to trauma and selected among those under follow-up at the Rehabilitation Service of DOT/ HC-UNICAMP were assessed. Shoulder pain complaint was not an inclusion criterion, since we intended to identify sub clinical injuries. The individuals were divided into four subgroups:
• Subgroup A: paraplegic patients undergoing rehabilitation with the aid of crutches or walker;
• Subgroup B: paraplegic patients undergoing rehabilitation with the aid of wheelchairs;
• Subgroup C: quadriplegic patients undergoing rehabilitation with the aid of wheelchairs;
• Subgroup D: quadriplegic patients undergoing rehabilitation with the aid of hangers and slipstream.
The criterion for subgroups division was the kind of motor sequel (paraplegia or quadriplegia) and the kind of rehabilitation program being followed by the patient (pair of crutches or walker, wheelchair, or hanger/ slipstream). All patients were diagnosed immediately after trauma by using nuclear magnetic resonance, determining the level of their spinal cord injuries (Table 1).
All selected patients follow a rehabilitation program of 3 hours a week divided into two periods of 1 hour and 30 minutes in alternate days.
The patients participating in the study signed an informed consent term (approved by the Committee on Ethics in Research, Medical Sciences College, UNICAMP) and answered to a questionnaire (Table 2).
The image-based assessment of patients was performed by means of ultrasound test on right and left shoulders, using a 6-9 MHz transducer (Toshiba Ultrasound, Power Vision 6000 model). The test assessed humeral big tuberosity (BT) and the small tuberosity (ST), the acromioclavicular space (ACS) and the subacromial space (SAS), tendons of the supraspinal muscle (SST), tendons of the subscapular muscle (SUT) (Figure 2), tendons of the infraspinal muscle (IST), tendons of the brachial biceps muscle's long stem (BBT) (Figure 3A) and subacromial bursa (SAB).
Spaces were assessed according to anatomical regularity and size; tendons were assessed regarding thickness, echotexture, rupture signs, presence of irregularities or fluid at synovial sheath; at the bursa, the presence of excessive amount of fluid was checked.
The results achieved were assessed according to statistical analysis.

Patient	Gender	Age	Injury level*	Injury time	Kind of Rehabilitation	Time of Rehabilitation	Time of Complaints**
1	M	46	T8	44m	walker/crutches	18m	no complaint
2	M	24	T9	85m	walker/crutches	12m	no complaint
3	M	31	T9	90m	walker/crutches	24m	24m
4	M	33	T5	226m	walker/crutches	12m	12m
5	M	55	T7	65m	wheelchair	18m	12m
6	M	34	T7	149m	wheelchair	04m	24m
7	M	27	T6	94m	wheelchair	12m	no complaint
8	M	17	T4	58m	wheelchair	06m	no complaint
9	M	32	T12	91m	wheelchair	24m	36m
10	M	45	C6	209m	wheelchair	24m	4m
11	M	41	C8	23m	wheelchair	03m	21m
12	M	39	C6	70m	wheelchair	12m	46m
13	M	28	C5	56m	slipstream	48m	24m
14	M	30	C5	135m	slipstream	18m	18m
15	M	27	C7	43m	slipstream	06m	6m
16	M	35	C4	66m	slipstream	12m	no complaint

*M= male; T= thoracic; C= cervical; m= months; *The most proximal level of injury was considered, based on diagnosis evidenced by nuclear magnetic resonance (NMR); **Related to the time of omalgic complaints onset.*

Table 1 - *Patients with Spinal Cord Injuries Submitted to Rehabilitation Program at DOT/HC-UNICAMP*

QUESTIONNAIRE FOR IDENTIFICATION AND CLINICAL EVALUATION OF PATIENTS WITH RACHIMEDULLARY INJURY FOLLOWED UP IN A REHABILITATION PROGRAM AT DOT - UNICAMP

1. Full name:
2. Gender: ( ) M ( )F
3. Age:
4. Dominant limb: ( )R ( )L
5. Injury level:
6. Kind of Injury: ( )Paraplegic ( )Quadriplegic
7. Time of injury:
8. Kind of rehabilitation/ time in program:
9. Shoulder pain? How long after onset? Bilateral?
10. Associated factors (daily activities associated to excessive joint use):

Table 2 - *Questionnaire for identification and clinical evaluation of patients with rachimedullary injuries followed up in a rehabilitation program at DOT-UNICAMP*

RESULTS

The selection of ultrasound as an imaging method for diagnosing anatomical injuries of the shoulder was made by considering the technical hurdles of submitting patients with spinal cord injuries to nuclear magnetic resonance tests, as well as its costs and the scarce availability of this resource in Public Health services in Brazil.
The mean age of the 16 patients was 32.5 years (ranging from 17 to 55 years), and the median was 34 years. Regarding the time of injury, the average was 94 months (ranging from 23 to 226 months), and the median was 94 months.
Among paraplegic individuals, rachimedullary injury was found between T4 and T12 level. On the other hand, in quadriplegic patients, this level ranged from C4 to C7 (Table 1).
The 4 patients constituting subgroup A presented with injuries

at T5 - T9 level, and had started Rehabilitation Program 12-24 months before (average: 16.5 months; standard deviation: 5.74; median: 15 months), 50% presented complaints related to the scapular-humeral joint.
The 5 patients constituting subgroup B presented injuries at T4-T12 level, undergoing Rehabilitation Program for 4-24 months (average: 12.8 months; standard deviation: 8.32; median: 12 months). Of these patients, 60% complained about shoulder pain.
The 3 patients constituting subgroup C presented injuries at C6-C8 level and had started Rehabilitation Program 3-24 months before (average: 13 months; standard deviation: 10.54; median: 12 months). In subgroup C, 100% presented with complaints related to scapular-humeral joint.
The 4 patients in subgroup D presented injuries at C4-C7 level. Rehabilitation Program had started 6-48 months before (average: 21 months; standard deviation: 18.65; median: 15 months), and 75% evolved with complaints related to scapular-humeral joint.
When tests were performed, muscle hypotrophy was seen in quadriplegic patients' shoulders (Figure 3B).
Of the studied patients, 68.75% (11/16) presented shoulder complaints, being 85.71% (6/7) of the quadriplegic patients and 55.56% (5/9) among paraplegic patients.

Figure 1 - *Paraplegic patient in Rehabilitation program using a walker*

The ultrasound test showed that 87.50% (14/16) of the patients presented changes in at least one of the structures assessed (Figure 3B, Figure 4, Figure 5). From these 14 patients, ten (71.43%) reported shoulder pain on the questionnaire presented at the beginning of the study (Table 2). Also, 90.91% (10/11) of patients presenting shoulder pain had some kind of imaging change.
Tendons of the rotator cuff muscle (Figure 4 and Figure 5) and of the long head of the brachial biceps (Figure 3) were the structures most frequently injured, as described on Table 3. Of the 32 shoulder assessed by ultrasound, 10 (31.25%) presented changes on supraspinal muscle tendon. The incidence of change on the subscapular muscle tendon was 37.50% (12/32), while changes occurred to the long stem of the brachial biceps muscle's tendon in 21.88% (7/32).
Changes on the big or small tuberosity were detected in only 4 of the 32 tests (12.50%).

DISCUSSION

Overall, 68.75% (11/16) of the studied patients presented shoulder complaints, being 85.71% (6/7) of the quadriplegic patients, and 55.56% (5/9) of the paraplegic patients, corroborating to the finding reported by literature of a higher incidence of complaints in quadriplegic patients[3,4].
In the ultrasound imaging tests performed, we found injuries in 4 (4/16) patients not complaining of shoulder pain, which can be regarded as subclinical injuries. As shown on Graph 1, the incidence of shoulder injury was higher for subgroup A, where 100% of the patients showed changes on ultrasound. However, 50% of these (2/4) presented with subclinical injuries. For quadriplegic patients, subclinical injury is found in one out of four patients in subgroup D (25%), accounting for only 14.29% (1/7) of the quadriplegic patients. Pain-free shoulder injury was found in 20% of the patients in subgroup B, totaling 33.33% (3/9) of the paraplegic patients.
The high incidence of injury in patients using crutches or walker is probably related to the greater shoulder use. According to data obtained by means of questionnaires (Table 2), these patients perform a larger number of routine activities, leading to a higher degree of scapular-humeral joint wear off.
All quadriplegic patients presenting pain and ultrasound changes showed injuries on rotator cuff, as shown by Table 3. Oppositely, the four patients using walkers or crutches showed some kind of ultrasound change (4/4), and in 50% (2/4),

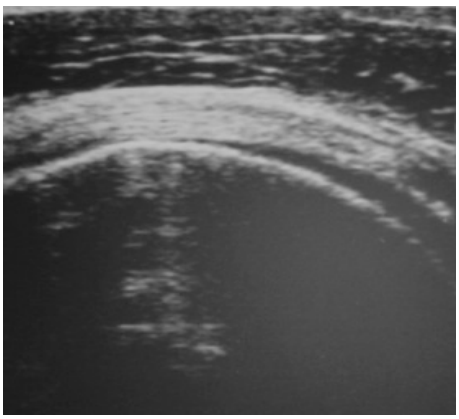


Figure 2 - *Normal subscapular muscle tendon: Cross-sectional plane of the subscapular m. with parallel tendinous fibers and usual hyperechogenicity.*

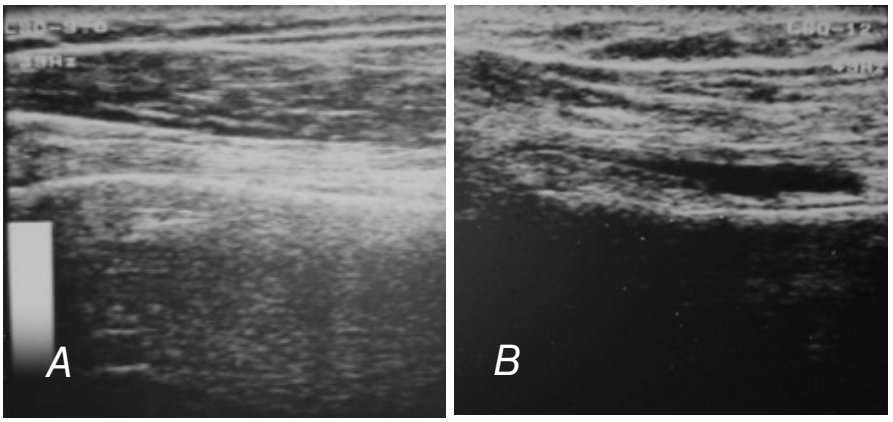


Figure 3 - *Longitudinal sections of brachial biceps muscle long heads' tendons.* ***3A:*** *Right shoulder of a paraplegic patient, with preserved echogenicity and echotexture of tendinous fibers.* ***3B:*** *Left shoulder of a quadriplegic patient, with tendinous fibers apparently normal, with the presence of fluid layer in the synovial sheath. In this patient, we found a bilaterally increased echogenicity and apparent reduction of deltoid muscle fibers thickness, consistent with atrophy, which may be related to non-use associated to denervation or not.*

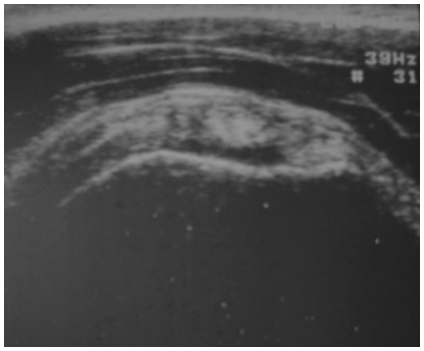


Figure 4 - *Subscapular muscle tendinopathy. Cross-sectional plane of the left subscapular muscle evidencing increased thickness and tendon heterogeneity. Deep hypoechogenic peripheral area, next to tendinous insertion, consistent with partial rupture at critical zone.*

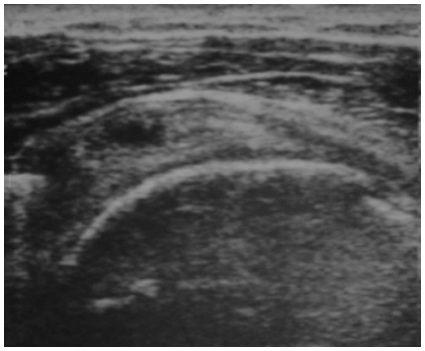


Figure 5 - *Partial intra-substantial rupture of the supraspinal muscle: Longitudinal plane of supraspinal muscle tendon showing a hypoechogenic round area within the tendon, consistent with partial rupture of fibers.*

Patient	Dominant limb	BBT		SST		SUT		IST		EAC		SAS		SAB		BT		ST	
		R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L
1	R	-	-	P	P	P	P	P	P	-	-	-	-	-	-	-	-	-	-
2	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P
3	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
4	R	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	R	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
6	R	P	P	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-
7	R	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	R	-	-	P	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-
10	R	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	P	-	P
11	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	R	-	P	P	P	-	P	-	P	-	-	-	-	-	-	-	-	-	-
13	R	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
14	R	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
15	R	-	-	P	P	P	P	-	-	-	-	-	-	-	-	-	-	-	-
16	R	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

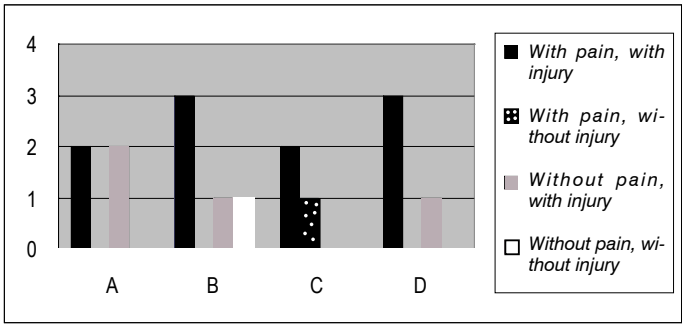
R= right; L=left; BBT= brachial biceps long stem's tendon; SST= supraspinal muscle tendon; SUT= subscapular muscle tendon; IST= infraspinal muscle tendon; ACS= acromioclavicular space; SAS= subacromial space; SAB= subacromial bursa; BT= big tuberosity; ST= small tuberosity; P= presence of changes on tests.

Table 3 - *Results of Ultrasound Tests on the Shoulders of Patients with Spinal Cord Injuries Followed up at DOT/HC-UNICAMP*

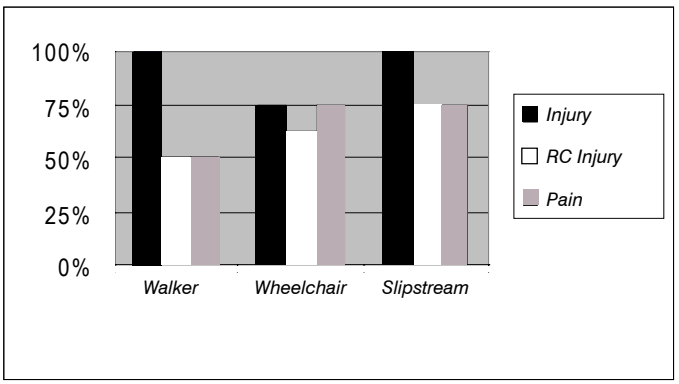
the changes happened on rotator cuff tendons (Graph 2). In 60% (3/5) of the paraplegic patients using wheelchairs, changes to rotator cuff were found. The presence of muscle hypotrophy in quadriplegic patients, viewed at ultrasound, favors overload to these tendons, corroborating the concept of a more frequent emergence of such injuries.

As oppositely to the findings on general population, in which the tendon of the supraspinal muscle is the most frequently affected structure[14], in the present study, a lower incidence of supraspinal muscle injuries was reported (7 patients, Figure 5) compared to the subscapular muscle (9 patients, Figure 4). This significant prevalence of injuries on subscapular muscle tendon shows a characteristic of these patients, suggesting a greater inner rotation requirement of the shoulder. This requirement occurs especially when transferring the patient from the chair to the bed or vice-versa, and when driving the wheelchair ahead.

Changes on humeral tuberosities were seen in a small number of patients (Table 1), not constituting a significant set of data, and these may happen because of an increased tendinous requirement by the movements performed on glenohumeral joint related to a more extensive use of shoulders in patients using crutches or walkers (2 of 4 patients in subgroup A), suggesting an early osteoarthrosis process.



Graph 1 - *Correlation between Pain and Injury Evidenced by Ultrasound for the 4 subgroups.*



RC= Rotator Cuff

Graph 2 - *Correlation between different kinds of Rehabilitation with the presence of injury in general and Rotator Cuff injury in particular*

CONCLUSION

The shoulder, particularly the scapular-humeral joint, is primarily designed for providing mobility, allowing for upper limb movements, and, together with the elbow, to position hand in space. Whenever this complex joint mechanism - additionally to provide motility - starts to act as a load joint, as in the case of spinal cord injured patients, degenerative changes manifest early.

We found that patients with spinal cord injuries submitted to rehabilitation programs frequently present with shoulder pain (68.75%), being more common in quadriplegic patients (85.7%). Establishing a correlation between this algesic picture and ultrasound-detectable anatomical changes was not possible.

However, the presence of injuries noticeable on ultrasound without concurrent pain complaints (subclinical injuries) is not neglectful (25%), apparently showing a trend to occur more frequently in paraplegic patients (33.3%).

The involvement of the subscapular muscle tendon (56.25% - 9/16) in a higher rate than supraspinal muscle tendon (43.75% - 7/16) corroborates the idea of an overload to shoulders' inner rotation movements, suggesting a correlation of the excessive use of inner rotators of the shoulder for performing activities of daily life, which, associated to muscular hypotrophy detected in quadriplegic patients, may favor tendinous injuries of the shoulder. This finding points out to the need of implementing an early program of strengthening exercises to internal rotator muscles, such as the subscapular and major pectoral combined to postural guidance and adjustments in activities of daily life.

The small number of studies in literature reporting a correlation between patients with spinal cord injuries and shoulder pain, in addition to the findings in our study, enables us to assume that this kind of complaint is not sufficiently researched or values when providing care to this group of patients.

When the shoulder starts to act as a load joint - as in the case of individuals with spinal cord injuries - it causes frequent pain manifesting in every phase of injury progression. This symptom should be valued by implementing protection and strengthening programs to rotator cuff tendons aiming to improve these patients' rehabilitation and quality of life.

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