Rotator cuff surgery in persons with spinal cord injury: relevance of a multidisciplinary approach

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**Background:** This article is a prospective review of patients with spinal cord injury who underwent multidisciplinary consultation from January 2005 to September 2013 for pain in one or both shoulders.

**Methods:** We performed clinical, functional, and lesion evaluations of 38 patients with paraplegia and quadriplegia presenting with rotator cuff pathologies.

**Results:** Surgery was indicated and performed on 38 shoulders in 28 patients. The lesion assessment during surgery showed injuries that were more severe than one would have thought based on imaging data. The mean pain intensity rating in the operative and nonoperative groups was 0 and 1.6, respectively, at rest and 2 and 4.9, respectively, during paroxysmal peaks. On average, for patients who had surgery, the Functional Independence Measure score decreased by 2.3. The mean satisfaction index in operated patients was 8.5 of 10.

**Conclusions:** When the surgical indication was based on a multidisciplinary decision, no negative results were reported that could have challenged the validity of this decision. Pain relief was the primary benefit reported after surgery. The functional status was modified because of the technical aids needed to prevent shoulder overuse. There are several arguments in favor of rotator cuff surgery for wheelchair-bound patients with spinal cord injury. Because of their functional impairments, wheelchair-bound patients will continue to overburden their shoulders after rotator cuff surgery. A multidisciplinary approach emerges as the solution to inform and educate patients to limit the risk of recurrence.

**Level of evidence:** Level IV, Case Series, Treatment Study.

**Keywords:** Rotator cuff; shoulder; surgery; pain; spinal cord injury; paraplegia
Rotator cuff injuries and shoulder pain are both quite common in persons with spinal cord injury (SCI) and have a negative impact on their autonomy in activities of daily living and quality of life even in the early stages of SCI. These injuries are often bilateral and related to the long-term use of wheelchairs (eg, repetitive movements during transfers and propulsion and arm movements above shoulder level), as well as orthotic-assisted walking.

Many authors report that the prevalence of shoulder pain is greater in patients with paraplegia and increases regularly between 5 years (30% to 50%) and 20 years (70%) after SCI. Conversely, in patients with quadriplegia, maximum shoulder pain occurs early on in the acute phase (0 to 5 years after SCI) and is found in 78% of patients within the first 6 months after SCI.

In 75% of patients with painful shoulders, the term “weight-bearing shoulder” can hide real shoulder pathologies, from simple tendinitis to more severe degenerative lesions, alone or combined (ie, rotator cuff tear, arthritis of the glenohumeral joint, subacromial bursitis, biceps tendinopathy, or avascular necrosis of the humeral head). Data from the literature underline a real discrepancy between the reality of these injuries and the clinical picture, which is often less discriminating in patients with SCI than in healthy populations. In fact, usually because of delays in consultations being performed and a proper diagnosis being obtained, we observe a rapid degeneration of these injuries in this SCI population, with 63% of patients with paraplegia having rotator cuff injuries versus 15% of healthy control subjects matched for gender and age.

Rotator cuff surgery, which is commonly indicated in non-neurologic patients, is still not largely proposed to patients with SCI because teams are afraid of postoperative dependence.

In January 2005, a multidisciplinary medical and surgical consultation was implemented in our SCI rehabilitation center, specializing in physical medicine and rehabilitation for neurologic impairments related to SCI lesions. This prospective, non-controlled study was designed to (1) refine the clinical, functional, and lesion profile of patients with SCI who underwent consultations for shoulder pain; (2) study and compare the clinical and functional progression of patients who underwent (or did not undergo) rotator cuff surgery; and (3) detail recommendations for shoulder management in persons with SCI.

Each patient had a complete medical evaluation to collect anamnestic, clinical, and lesion data. Anamnestic data comprised the following: age at consultation, age at SCI, neurologic profile, American Spinal Injury Association Impairment Scale (ASIA), and preoperative functional status by use of the Functional Independence Measure (FIM) assessing physical impairments (13 items) and cognitive impairments (5 items). Each item on the FIM scale is scored from 1 to 7 (where 1 indicates complete dependence and 7 indicates complete independence). The scale ranges from 18 to 126. The FIM scale is mainly used to track changes in a person’s ability to carry out an activity in an independent manner.

Clinical data comprised the following: nature of the complaint (pain, functional impairment, and/or joint range-of-motion [ROM] limitation); results of the joint examination (passive and active joint limitations, decentered glenohumeral joint, and/or joint instability); results of the musculotendinous examination (subacromial conflict, tendon pathology, and rotator cuff tear evaluation tests); and circumstances surrounding pain aggravation or its onset (transfers, propulsion, movements above shoulder level to reach objects, and/or other situations).

Lesion data comprised imaging data (plain radiographs and/or ultrasound data when there was evidence of subacromial impingement syndrome and/or computed tomography [CT] arthrography or magnetic resonance imaging [MRI] for rotator cuff injuries).

Some patients underwent specific physical therapy (8 sessions on average) associating functional rehabilitation, therapeutic education, and recommendations for limiting stress on their injured shoulders.

Surgical management was guided by the intensity of the pain and its functional impact, as well as the importance of injuries as evidenced on imaging. The surgeon chose the surgical technique during arthroscopic or open surgery after determining the severity of the lesions and defined the medical/surgical treatment strategy based on 8 principles (Fig. 1). The patient, under general anesthesia, was placed in a semi-sitting position. Arthroscopic rotator cuff repair first consisted of scapulohumeral arthroscopy, followed by subacromial bursectomy to precisely assess the lesions.

For supraspinatus, infraspinatus, and subscapularis tendon repairs, the surgeon reattached the torn tendon with one or several anchors (single-row repair for partial tears and double-row repair for total rotator cuff tears).

Arthroscopic tenodesis was the first-line treatment for repair of the long head of the biceps. For acromial spurs causing lesions to the shoulder and reducing the subacromial space, the technique consisted of recalibrating the coracoclavicular arch by conservative anterior acromioplasty with removal of the acromioclavicular ligament with or without acromioclavicular arthroplasty. A subacromial tendon bursectomy was sometimes performed to complete the procedure to remove any bony prominences and irregular tendon edges with or without tenosynovectomy of the biceps sheath.

Open rotator cuff surgery consisted of making an incision above the shoulder to detach the anterior deltoid and then proceeding with cutting the medial deltoid heads along their fibers before rotator cuff repair was performed by transosseous reattachment.

All patients were seen in a prospective manner after the operation or at some time after their last multidisciplinary consultation if they did not undergo surgery.

Methods

All adults with SCI who underwent a multidisciplinary consultation between January 2005 and September 30, 2013, for unilateral or bilateral shoulder pain and/or shoulder-related functional impairments were seen in a prospective manner. Exclusion criteria were patients who had unstable psychiatric pathology and/or were deemed unable to answer questions pertaining to the study.
The follow-up indicators were as follows:

- Maximum pain intensity and pain intensity at rest evaluated with a verbal numeric scale ranging from 0 to 10
- Active and passive ROM of the operative shoulder in complete abduction, internal rotation with the arm at the side, and external rotation with the arm at the side
- Resistance of the supraspinatus during the Jobe relocation test
- Resistance of the infraspinatus during the Patte test
- Functional status after surgery using the FIM scale
- Level of satisfaction with medical and/or surgical outcomes measured with a verbal numeric scale ranging from 0 to 10 (where patients were asked the following question: "How satisfied are you with the outcomes of your shoulder surgery, both in terms of pain relief and improvement in strength and function? Please rate your overall satisfaction on a 10-point scale with 0 = very dissatisfied and 10 = very satisfied.")
- Preventive actions implemented to spare the shoulder(s)

Results

Population

Thirty-eight patients were referred to us to undergo neuro-orthopedic multidisciplinary consultations. There were 6 women and 32 men. Of the patients, 4 had quadriplegia and 34 had paraplegia, with AIS grade A in 27 cases, AIS grade B in 3 cases, and AIS grade C in 8 cases. The level of SCI is reported in Figure 2. During the first consultation, the mean age and mean time since SCI were 54.1 ± 7.9 years (range, 27.9 to 68.7 years) and 26.4 ± 11.2 years (range, 0.1 to 43.1 years), respectively. Thirty-two patients were still driving their cars, and 9 were involved in sporting activities.

Clinical data

For 13 patients, the complaint only involved 1 shoulder, whereas 25 patients had bilateral complaints. Pain was always present in all 63 shoulders, functional impairment was seen in 45 of 63 cases, and passive or active limited ROM was found in 23 of 63 cases. Clinical examination showed tendinitis of the rotator cuff or the long head of the biceps in 43 cases, subacromial impingement syndrome in 44 cases, and instability in 4 cases.

The circumstances triggering or aggravating the shoulder pain (Fig. 3) were transfers, wheelchair propulsion, and lifting the arm above shoulder level. Some patients reported other aggravating factors: lying on the side of the painful shoulder, dressing, and participating in sporting activities. Two patients were affected by the consequences of orthotic-assisted gait, which required shifting the weight-bearing load on the upper limbs to stabilize gait.

Injury data

CT-scan arthrography was the imaging examination most used during preoperative assessment (54 cases); MRI was more rarely used (8 cases). In 12 cases, an ultrasound
evaluation was conducted before the previously listed imaging examinations. The types of injuries evidenced by imaging and during surgery are highlighted in Figure 4.

**Therapeutic data**

Surgery was indicated and performed in 38 shoulders in 28 patients. Surgery was indicated for 15 other shoulders but has not yet been performed—because of a pressure ulcer on the buttocks in 1 case and because of the patients’ refusal in the other 14 cases. The various reasons expressed for the patients’ refusal were quite different from one another: fear of increased dependence during the postoperative period (3 cases), contradicting recommendations from another physician (2 cases), disappointment in the surgical outcomes for the other shoulder (1 case), disappearance of or decrease in pain (4 cases), and lack of time (1 case). In 5 cases, the patients asked for more time to think about undergoing surgery.

Surgery was not indicated for 7 shoulders for the following 3 reasons: insufficient pain to justify surgery (3 cases), widespread rupture with tendon retraction and important muscle adipose degeneration (3 cases), and severe shoulder arthritis requiring total shoulder replacement (1 case). Finally, 3 shoulders are still awaiting a decision: 2 are undergoing medical care management with associated rehabilitation and therapeutic education to spare the joint and 1 is awaiting cardiologic approval for anesthesia.

For the 28 patients who underwent surgery, the mean time since SCI was 28 ± 10 years (range, 3 to 44 years). Laparoscopy was performed in 33 cases and open surgery in the other 5 cases.

For each rotator cuff muscle (Fig. 5), the procedures involved a great number of tendon reattachments, mainly the supraspinatus, infraspinatus, and subscapularis tendons, and 5 of 20 cases required a biceps tenotomy transfer. Acromioplasty was performed in 37 of 38 shoulders, and resection arthroplasty of the acromioclavicular joint was performed in 13 shoulders. Most often, a tendon bursectomy protocol completed the rotator cuff repair procedure (31 of 38 shoulders).

**Data related to progression**

Only shoulders seen in multidisciplinary consultations were included in the follow-up. Of the 38 operative shoulders, 36 had a mean postoperative follow-up period of 1.5 ± 1.9 years (range, 0.2 to 2.9 years). Two shoulders in
two patients are still undergoing postoperative rehabilitation care. These shoulders are included in our sample, but data related to pain progression and functional independence for these shoulders have not been included within the results. All 25 nonoperative shoulders were followed up, with a mean post-consultation follow-up period of $3 \pm 2.2$ years (range, 0.5 to 8.3 years).

Shoulder passive and active ROM, as well as the differential, are detailed in Table I. The negative differential between passive and active ROM was greater for the operative group in abduction and for the nonoperative group in the positions of internal rotation with the arm at the side and external rotation with the arm at the side. For the 36 operative shoulders and for 12 of 22 nonoperative shoulders, we found satisfactory resistance of the supraspinatus (Jobe relocation test). Furthermore, for the 36 operative shoulders and 17 of the nonoperative shoulders, we found satisfactory resistance of the infraspinatus.

The mean pain intensity rating at rest, free from shoulder movements, was $0 \pm 1.3$ (range, 0 to 6) for operative shoulders and $1.8 \pm 2$ (range, 0 to 6) for nonoperative shoulders. The maximum pain intensity rating during daily

Figure 4  Types of rotator cuff injuries evidenced by imaging data (top) and observation during surgery (bottom). AD, Adipose degeneration; CR, complete rupture; CT, calcifying tendinitis; DI, dislocation; I/T, irregularity; PR, partial rupture; T/E, thickening/edema.

Figure 5  Surgical procedures in 38 shoulders in 28 patients.
movements reached a mean of 2 ± 2.2 (range, 0 to 7) for operative shoulders and 5.1 ± 2.9 (range, 0 to 8) for nonoperative shoulders.

In the group of patients who had rotator cuff repair, the mean satisfaction index was 8.5 ± 2 (range, 0 to 10) with the 25th percentile estimated at 8.

The mean preoperative and postoperative FIM scores were 103 ± 14.1 (range, 63 to 126) and 104 ± 10.6 (range, 81 to 120), respectively. The differential between postoperative and preoperative FIM scores was negative on average and estimated at −1.2 ± 9.2 (range, −16 to 31).

Finally, recommendations to reduce shoulder overuse in activities of daily living were given to 35 patients, including the use of an electric wheelchair, a lighter manual wheelchair, or a verticalizing wheelchair (23 patients) or the acquisition of motorized wheels for the wheelchair (5 patients). Some patients were encouraged to limit the number of transfers or to change the transfer technique (4 patients), to use a transfer board (8 patients), or to use technical aids or a third party (5 patients). Two patients were advised to abandon orthotic-assisted gait. In all cases, their home environments were adapted accordingly. Five patients bought equipment to help load their wheelchairs into their cars. Two other patients preferred to have direct wheelchair access to their cars. Some patients had to stop working (2 patients) or reduce their leisure activities (ie, sporting or do-it-yourself activities) (2 patients).

Discussion

The main goal of this study was to highlight all the multidisciplinary competencies gathered around the patient (physician, surgeon, physiotherapist, and occupational therapist) and how essential these are in deciding to perform rotator cuff surgery rotator cuff surgery in patients with SCI to, foremost, avoid rotator cuff tendon/muscle degeneration and limit its functional impact.

First indication for surgery: pain relief

Postoperative results show functional stability and real satisfaction in terms of pain relief, even if some residual but less intense pain is still reported by some patients during repetitive and intense movements.

Preventive surgery aims at slowing down the progression of rotator cuff lesions, whereas repair surgery aims at restoring rotator cuff functions. Whether undergoing preventive or reconstructive surgery, all patients were satisfied with the pain relief outcomes after surgery. The minimally invasive surgical procedures did not yield any adverse event that could have impaired the global functional status of the patient. Postoperative functional evaluations (Jobe relocation test and Patte test) after supraspinatus or infraspinatus repair show the sturdiness of the repair and that, in most cases, the solicited muscles responded very well in terms of resistance, thus highlighting the relevance of the surgical indications.

Impact of delay in consulting for shoulder pain

Some patients were quite old when they first underwent our multidisciplinary consultation for their rotator cuff lesions. The mean age at consultation was 54 years. At that time, because of associated impairments, the functional impact was already quite important and negatively affected the quality of life of these older patients, as compared with younger patients, and the lesions were already quite severe. As Bayley et al reported, there is a great disparity between imaging diagnostic and lesion severity when comparing the types of rotator cuff lesions evidenced using imaging findings versus clinical observation during surgery. Our results partly match those results, except that in our study, the lack of homogeneity in imaging diagnostic examinations preoperatively introduced a slight bias that should be taken into account. MRI was performed in 8 of the 63 painful shoulders, whereas CT-scan arthrography
was used in all other shoulders but 1 (with ultrasound examination only). Akbar et al\(^2\) recommended consultation early on for rotator cuff pain because a correlation was evidenced between age and time since SCI on the one hand and severity of the lesions on the other hand.

### Relevance of multidisciplinary approach

Some patients followed a shoulder rehabilitation program before the team decided on surgery. The objective of this rehabilitation was to measure the real impact of pain on functional abilities, study the impact of analgesic therapies, and evaluate the benefit-risk ratio of a potential surgical procedure. This shoulder rehabilitation program was limited in time (8 sessions in our clinical experience).

In fact, surgeons are not the only actors in the decision-making process; their decision is based on recommendations from the physical medicine and rehabilitation team, which in turn informs the patient of the risks because the surgical procedure, even when justified, is not the only therapeutic alternative. The team needs to take into account the patient’s functional requirements and the quality of the patient’s family and work environment. The therapeutic choice and prevention must take into account lesion recurrence and pain after the intervention. A tool in a checklist format (similar to the tool used in back schools for back pain\(^10\)) covers most strategies to avoid shoulder overuse: joint preservation, correcting shoulder muscle imbalance and posture, managing aggravating factors, and changes in transfer techniques (Table II):

### Table II  Checklist of preventive strategies to minimize shoulder pain in patients with SCI

<table>
<thead>
<tr>
<th>Joint-sparing strategies</th>
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<tbody>
<tr>
<td>Bringing the patient to the shoulder-level environment:</td>
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<tr>
<td>Lift</td>
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<tr>
<td>Verticalizing wheelchair</td>
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<tr>
<td>Adapting the patient's home environment</td>
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<tr>
<td>Therapeutic education to prevent untimely and unexpected movements</td>
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<tr>
<td>Limiting propulsion movement: electric wheelchair</td>
<td></td>
</tr>
<tr>
<td>Optimizing manual propulsion: motorized wheels</td>
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<tr>
<td>When relevant in patients with quadriplegia with shoulder pain, opting for functional elbow surgery to restore symmetric propulsion of the wheelchair</td>
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<tr>
<td>Adapting the patient's car for minimizing shoulder involvement when driving</td>
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<tr>
<td>Using various technical aids for taking a shower, storing the wheelchair in the car, and so on</td>
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<tr>
<td>Postural correction</td>
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<tr>
<td>Postural rehabilitation to correct kyphosis</td>
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<tr>
<td>Sitting correction for wheelchair</td>
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<tr>
<td>Back-support correction for wheelchair</td>
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<tr>
<td>Progressive modulating adaptation</td>
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<tr>
<td>Postural corrections in bed</td>
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<tr>
<td>Specific shoulder muscle strategies</td>
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<tr>
<td>Preventing and avoiding joint stiffness</td>
<td></td>
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<tr>
<td>Preventing muscle tone disorders (eg, major pectoralis spasticity)</td>
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<tr>
<td>Balanced deltoid/major pectoralis/teres minor strengthening</td>
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<tr>
<td>Balanced anterior/posterior muscles</td>
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<tr>
<td>Selective training of external rotators (infraspinatus and teres minor)</td>
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<tr>
<td>Recentering maneuver for glenohumeral joint</td>
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<tr>
<td>Curtis stretching protocol: 2 sessions per day, holding the final position for 20 to 30 seconds, with 1 series of 5 stretching movements</td>
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<tr>
<td>- Stretching major pectoralis (sternal and clavicular) and anterior muscles</td>
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<tr>
<td>- Stretching external rotators—strengthening: 1 session per day, 3 series of 10 to 15 movements</td>
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<tr>
<td>- Strengthening scapula-suspending muscles</td>
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<tr>
<td>Managing aggravating factors</td>
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<tr>
<td>Preventing weight gain and obesity</td>
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<tr>
<td>Preventing muscle fatigue</td>
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<tr>
<td>Endurance training</td>
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<tr>
<td>Preventing spastic diffusion to trunk and upper limbs</td>
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<tr>
<td>Advising against practicing deleterious sporting activities (eg, bench press)</td>
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<tr>
<td>Adapting to new transfer techniques</td>
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<tr>
<td>Using technical aids (eg, transfer board)</td>
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<tr>
<td>Using pivot-transfer technique when possible or helped by a third party</td>
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<tr>
<td>Adapting height of transfer planes</td>
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</table>
• Implementation of prevention-targeted changes for performing wheelchair-to-bed and wheelchair-to-car transfers (and vice versa)
• Looking at the option of automated mobility (eg, E-motion for manual wheelchairs or electric wheelchairs)
• Correcting postural disorders of the trunk to decrease the proximal overuse of the upper limbs
• Informing athletes and persons with high levels of physical activity about the risks taken when the lesion is evidenced but does not require surgery or after shoulder repair

Given the increasing prevalence of rotator cuff lesions, it is quite paradoxical to observe that some physicians are reluctant to perform shoulder surgery in SCI populations. The dearth of publications and the very small sample sizes of operative patients underline this extreme caution. The rare publications are limited to case studies. The surgical decision is in fact more difficult for the patient than for the surgeon. In our study, some patients did not dare risk it and others were afraid of the postoperative rehabilitation period and its induced functional dependence. However, when patients were informed and supported by our multidisciplinary team (surgeon, physician, physiotherapist, and occupational therapist) and were given the opportunity to share their concerns with other patients, they were able to make an enlightened decision. In 1997, Goldstein et al reported the cases of 5 operative shoulders in 4 patients with paraplegia, with negative results for large and degenerative rotator cuff lesions and positive results for minimally invasive repair of an isolated supraspinatus lesion. Popowitz et al, in a retrospective study of 8 shoulders in 5 patients with SCI (4 patients with paraplegia and 1 patient with quadriplegia and incomplete SCI), reported—for moderately severe lesions—a high satisfaction rate for 7 of 8 operative shoulders; furthermore, all 5 patients who underwent surgery were inclined to recommend it to other patients. However, there were no recommendations on surgical modalities and the rationale for patient selection. Robinson et al reported the same positive experience in 4 patients with isolated supraspinatus tears in one or both shoulders treated with acromioplasty and tendon reattachment.

Conclusion

For persons with paraplegia or quadriplegia, the upper limbs are key actors for functional abilities. This is why it is essential to detect and screen for rotator cuff pain in persons with SCI and offer patients a multidisciplinary therapeutic strategy taking into account various clinical and functional parameters. Surgery is a highly reliable therapeutic answer not only to alleviate pain that can sometimes be unbearable, especially when added to other painful areas, but also to prevent functional deterioration. This study suggests that rotator cuff surgery, whether for prevention or reconstruction, yields a good level of satisfaction with reliable, sturdy and qualitative tendon repair not impairing postoperative function. However, one must be aware of the potential frailty of the repaired shoulder and the need to integrate the overall care management of rotator cuff lesions into an “educational” concept to inform and educate patients on prevention and joint-preservation strategies.

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Disclaimer

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