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ORIGINAL ARTICLE

Observational Study

Functional outcomes of traumatic and non-traumatic rotator cuff tears after arthroscopic repair

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Abstract

AIM

To compare the functional outcomes of traumatic and non-traumatic rotator cuff tears after arthroscopic repair.

METHODS

Eighty-seven patients with rotator cuff tears following arthroscopic treatment were divided into traumatic and non-traumatic tear groups. Postoperative muscle strength and outcomes using the modified University of California, Los Angeles score were evaluated. Sex, age, affected limb and dominant limb were correlated between groups. Muscle strength of the repaired and unaffected shoulders was compared. Rotator cuff injury size was measured.

RESULTS

Of the 87 patients who underwent rotator cuff repairs, 35 had traumatic tears and 52 had non-traumatic tears. In patients with non-traumatic tears, the average age was 59 years, 74.5% were female, 96.1% were right-hand dominant and 92.3% had their dominant shoulder affected. Patients with traumatic tears were 59.5 years

old on average, 51.4% were female, 91.4% were right-hand dominant and 88.5% had their dominant shoulder affected. No difference existed in the mean modified University of California, Los Angeles score between patients with traumatic tears (33.7) compared with those with non-traumatic tears (32.8). No strength differences were observed between groups: The strength difference between the non-affected and affected sides was 1.21 kg in the non-traumatic group and 1.39 kg in the traumatic group (P = 0.576), while the strength ratio between the non-affected/affected sides was 0.805 in the non-traumatic group and 0.729 in the traumatic group (P = 0.224).

CONCLUSION

The functional results of traumatic rotator cuff repairs are similar to non-traumatic tears. Both outcomes are satisfactory.

Key words: Rotator cuff; Shoulder pain; Arthroscopy; Tendon injuries; Orthopedics

Core tip: The causes of rotator cuff tears are multifactorial. It is believed that degeneration is essential, and most tears are slow and progressive. In contrast, acute tears can occur after trauma. Acute tears generally have better functional and pain outcomes compared with chronic injuries. The aim of this study is to compare shoulder functional outcomes after arthroscopic rotator cuff repair of traumatic and non-traumatic tears. Outcomes will be evaluated using the modified University of California, Los Angeles score and muscle strength measurements.

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INTRODUCTION

Rotator cuff injuries are very common, ranging from 5%-39%. They are the leading cause of shoulder pain, and have a high prevalence in the aging population[1]. They can cause intense shoulder pain, functional limitation and decreased quality of life[2-7]. It is extremely important to understand these injuries to treat them appropriately, as it is likely that every physician, not just orthopedic surgeons, will encounter this pathology.

The rotator cuff is a group of muscles that cover the humeral head and plays an important role in the strength, mobility and stability of the shoulder by fixing the humeral head to the glenoid. The rotator cuff consists of four muscles: Subscapularis, supraspinatus, infraspinatus and teres minor. The tendons of these muscles merge with the joint capsule. Around the shoulder joint and between the tendons of the rotator cuff muscles and the fibrous joint capsule, bursa reduces the friction of the tendons that pass over bone or other areas of resistance[8].

In general, the treatment for rotator cuff tears should be clinical, even in cases in which anatomic changes are also present[9]. However, in cases of rotator cuff failures, surgical treatment is indicated[4]. Rotator cuff repairs can be performed through either arthroscopic or open approaches. Arthroscopic surgery is performed through micro incisions and preserves the deltoid muscle insertion, theoretically permitting early rehabilitation and a lower risk of iatrogenic injuries or complications from deltoid healing.

The causes of rotator cuff tears are multifactorial. However, it is believed that degeneration is an essential factor, as this leads to a high rate of non-healing or failures, which range from 10%-94%[10-17]. In most cases, rotator cuff tears are slow and progressive injuries, occurring after a relatively long period of symptoms. However, acute tears can also occur secondary to trauma. This mechanism has been found to have better functional and pain outcomes than chronic injuries.

We therefore decided to compare functional outcomes after arthroscopic rotator cuff repairs of those patients who sustained traumatic rotator cuff tears, and those without traumatic etiologies. This may help us understand the post-surgical function of these patients, and support clinical decision making.

MATERIALS AND METHODS

This is a retrospective study of 87 adult patients with rotator cuff injuries treated arthroscopically at the Hospital Ortopédico de Belo Horizonte. Most of them were operated from June to December 2014, and the others were retrospectively selected by medical records. All patients were informed about the objectives of this protocol and signed a consent form agreeing to participate in the study. The study was approved by the National Ethics Committee on Research.

The average patient follow-up was 43 mo (range 24-72 mo). Lesions were characterized clinically and with magnetic resonance imaging, and the criteria for surgery was determined after a discussion meeting.

The traumatic rotator cuff tear group was defined[18] by trauma followed by acute shoulder pain associated with impaired active range of motion of the affected limb. This trauma can be a cause of a medial rotation or lateral force with the arm adducted or abducted, a ventral, medial or caudal passive draw force, an axial compressive force toward the cranial and ventral or ventromedial direction or secondary to a shoulder dislocation. It was expected that the patient did not have any pain before the trauma. In all cases, fractures were excluded using anteroposterior, lateral and axillary radiographs of the affected shoulder. In this group,

surgeries were performed within six months after the traumatic event.

For the non-traumatic rotator cuff injury group, inclusion criteria were a chronic history of shoulder pain with pre-existing limited shoulder function. Acromioclavicular osteoarthritis and osteophytes of the acromion are also commonly observed.

Exclusion criteria included: Bilateral lesions, previous surgery in the affected limb, patients that required other upper extremity surgical procedures after the rotator cuff repair and any condition that would interfere with the evaluation of long term outcomes, such as rheumatoid arthritis or fractures. Patient demographics of interest included sex, age, affected limb, dominant limb and mechanism of injury (traumatic or non-traumatic).

All patients were evaluated 24 mo after surgery, since most cases of re-rupture occur before two years after surgery[19-21]. In patients who were selected retrospectively, we used the evaluations performed within 24 mo. The primary outcome was modified University of California, Los Angeles (UCLA) score validated for the Portuguese language, which takes into account pain, function, range of motion, strength and patient satisfaction[22,23].

The modified UCLA scale is scored out of a total of 35 points. Subsections include: Pain (10 points), function (10 points), active forward flexion range of motion (5 points), a manual strength test for forward flexion (5 points) and patient satisfaction (5 points). Outcomes according to this scale are as follows: 34-35 points correspond to excellent results, 28-33 good, 21-27 satisfactory and 0-20 poor[23]. No minimum clinically important difference has been reported using this scale[24]. The modified UCLA scale can be easily applied, and allows for effective clinical tracking. It is also one of the only patient satisfaction scales that are validated for the Portuguese language[22].

Arm strength was measured with the patient positioned in orthostasis, with the upper limb in 90 degrees of elevation and angled 30 degrees anteriorly, corresponding to the abduction axis in the scapular plane[25]. We used a dynamometer that consisted of a household scale with a maximum capacity of 20 kg (Performance Plus, Performance Plus Ind. E Com. Ltda., Rio de Janeiro - RJ, Brazil). One end of the dynamometer was fixed to a fabric strap wrapped around the distal end of the forearm that was maintained in full pronation[26]. The other end of the dynamometer was secured to the scale's spring and attached to a nylon rope whose length reached the foot of the patient. The other end of the rope was secured with a handle attached to the patient's footwear. This setup allowed for force measurements with a fixed point (foot). The patient was asked to exert the maximum possible strength during upper limb elevation for 5 s. The final reading at the end of this period was used to represent limb strength[27]. We avoided placing the bracelet on the wrist or hand, where local muscle activity could confound our measurements. Avoiding this positioning also helped to keep the patient's trunk upright, avoiding compensation with lateral tilt. Muscle strength of the injured shoulder was compared with the unaffected side, and correlated with rotator cuff injury size.

Surgical technique

All patients received general anesthesia and a brachial plexus block. They were positioned in the lateral decubitus position with a vertical and longitudinal traction of 5 kg fixed to the affected arm. The arthroscope was introduced through a posterior portal positioned 2 cm medial and 2 cm below the posterolateral edge of the acromion. The joint was evaluated for degenerative or inflammatory changes, which were treated with synovectomy and debridement through an anterior portal along the top edge of the subscapularis muscle with a shaver blade. When the rotator cuff tendon injury was observed, a monofilament was introduced to demarcate the injury site, making it easy to locate during subacromial view.

Subacromial view was performed through the same posterior portal. The arthroscope was introduced into the subacromial space and a bursectomy was performed with the shaver blade introduced through a lateral portal.

The rotator cuff injury was repaired using 5 mm titanium suture anchors placed into the anatomic neck of the humerus. It was made single row repair with Revo knots. When the subacromial space was found to be pathologically decreased, an acromioplasty was performed as well. All arthroscopic portals were closed using monofilament suture.

Patients were immobilized postoperatively in a Velpeau sling (Mercur, Santa Cruz do Sul - RS, Brazil) for 6 wk. Sutures were removed 10-14 d after surgery. Patients were encouraged to start pendulous movements and elbow, wrist and hand range of motion immediately after surgery. Active motion was only permitted 6 wk after surgery, following evidence of restored strength and proprioception. It was used the same physical therapy protocol in both groups.

Statistical analysis

The statistical review of the study was performed by a biomedical statistician. A P-value < 0.05 was considered significant. Our confidence interval was 95%. A paired Student's t-test was used to compare outcomes between affected and unaffected shoulders. This test was selected because the same subject contributes to the experimental and control sample.

We used an analysis of variance (*ANOVA*) to compare subjects with and without a traumatic injury to the strength ratio of the affected and unaffected shoulder. The *ANOVA* was also to compare mean age, UCLA-modified score and strength differences between the affected and unaffected shoulders. The two-proportion equality test (χ^2 test) was used to compare the sex distribution of traumatic *vs* non-traumatic rotator cuff

Table 1 Sex distribution of patients with traumatic *vs* non-traumatic rotator cuff tears *n* (%)

Trauma	No	Yes	*P*-value
Female	38 (74.5)	18 (51.4)	0.027
Male	13 (25.5)	17 (48.6)	

Table 2 Average ages of patients with traumatic *vs* non-traumatic rotator cuff tears

Age	Trauma	
	No	Yes
Mean	59	59.5
Median	60	62
Standard deviation	8.4	9.7
Coefficient of variation	14%	16%
Minimum	40	42
Maximum	75	76
Patients	51	35
Confidence interval	2.3	3.2
P-value	0.799	

tears.

RESULTS

The clinical and functional data of 87 patients who underwent a rotator cuff repair were analyzed. Thirty-five had traumatic tears and 52 had non-traumatic tears. Both groups were treated using the same surgical technique. The mean follow-up was 43 mo (24-72 mo). Women composed 74.5% of non-traumatic rotator cuff tears, compared with 51.4% of traumatic tears. This difference in sex distribution was significant ($P < 0.05$, Table 1).

The average age of the non-traumatic group was 59 years, compared with 59.5 years in the traumatic group (Table 2). In the traumatic group, 91.4% were right-hand dominant and 88.5% had their dominant limb affected. In the non-traumatic group, 96.1% were right-hand dominant and 92.3% had their dominant limb affected. There was no difference in mean modified UCLA score between the non-traumatic (33.7) and the traumatic (32.8) groups (Table 3). The strength difference between the non-affected and affected sides was 1.21 kg in the non-traumatic group and 1.39 kg in the traumatic group ($P = 0.576$, Table 4).

There was no difference in the affected/non-affected strength ratio, which was 0.805 in the non-traumatic group and 0.729 in the traumatic group (Table 5). Significant differences were observed in the mean strength of the affected shoulder after surgery, which was 4.76 kg compared with 6.04 kg in the uninjured shoulder (Table 6). Tear size was 2.49 cm on average. It was 2.254 cm (range 1.0-5.4 cm) in the non-traumatic group and 2.84 cm (range 1.0-5.2 cm) in the traumatic group.

DISCUSSION

Rotator cuff injuries are multifactorial, and can include

Table 3 Modified University of California, Los Angeles scores of patients with traumatic *vs* non-traumatic rotator cuff tears

UCLA	Trauma	
	No	Yes
Mean	33.7	32.8
Median	35	35
Standard deviation	3.9	4.5
Coefficient of variation	12%	14%
Minimum	12	17
Maximum	35	35
Patients	51	35
Confidence interval	1.1	1.5
P-value	0.337	

UCLA: University of California, Los Angeles.

Table 4 Strength ratios between unaffected-affected shoulders of patients with traumatic *vs* non-traumatic rotator cuff tears

Unaffected-affected	Trauma	
	No	Yes
Mean	1.21	1.39
Median	1	1
Standard deviation	1.42	1.49
Coefficient of variation	117%	107%
Minimum	-1.5	-0.5
Maximum	6	4.5
Patients	51	35
Confidence interval	0.39	0.49
P-value	0.576	

degeneration because of age and microtrauma. Other factors that can increase the likelihood of a rotator cuff tear include smoking, hypercholesterolemia and genetics[28]. The pathophysiology of rotator cuff tears is more complex than previously believed. The mechanisms behind rotator cuff injury and healing have a direct impact on treatment and recovery.

One common mechanism of rotator cuff injury is direct trauma to the tendon. Another mechanism is gradual tendon degeneration with age, predisposing the rotator cuff to tears. A widely held theory regarding rotator cuff injuries is the vascular theory, in which lesions occur because of hypovascularization near the rotator cuff's insertion on the humerus. In general, the injury process is of a multifactorial origin[29].

Of the various factors that contribute to rotator cuff tears, such as trauma, subacromial impingement and hypovascularization, the most important is the aging process[30]. Aging is a major prognostic indicator of tendon degeneration[31]. The vast majority of rotator cuff ruptures occur in middle-aged and older patients[32,33]. Previous studies have shown that the prevalence of rotator cuff injuries increases with age, reaching 50% by the 8th decade of life[31].

Clinically, it is difficult to differentiate between patients whose rotator cuff injuries originate traumatically from those that have some degenerative component, as there is no way to know what degree of tendon degeneration occurred prior to the inciting

Table 5 Affected/unaffected shoulder strength ratio between patients with traumatic and non-traumatic rotator cuff tears

Strength ratio	Trauma	
	No	Yes
Mean	0.805	0.729
Median	0.833	0.857
Standard deviation	0.257	0.32
Coefficient of variation	32%	44%
Minimum	0.143	0
Maximum	1.6	1.083
Patients	51	35
Confidence interval	0.071	0.106
P-value	0.224	

Table 6 Affected *vs* unaffected shoulder strength

Strength	Affected side	Unaffected side
Mean	4.76	6.04
Median	5	6
Standard deviation	2.38	2.06
Coefficient of variation	50%	34%
Minimum	0	1
Maximum	11.5	12.5
Patients	86	86
Confidence interval	0.5	0.44
P-value	< 0.001	

trauma. This is especially important as a significant part of the population has some degree of asymptomatic tendon degeneration[3]. Several authors[18,34-36] proposed methods to differentiate between these two types of tears. However, there remains no established protocol. Therefore, because of the difficulty in differentiating between these two groups, we focused our analysis purely on those lesions that were diagnosed following trauma, rather than were determined to be of a purely traumatic origin. This may also provide greater clinical applicability to our findings.

In this study, the average age of the traumatic group was similar to the non-traumatic group. In the literature[37-39] there is greater age heterogeneity in studies that identify trauma as a causal factor in rotator cuff injuries (mean age 34.2-56.1 years). This may be because of the variability in the selection criteria for assigning patients to a "purely traumatic tear" group. Studies that examine degenerative injuries have greater homogeneity (mean age 54.1-62.6 years).

In our study, most patients with degenerative tears were female (74.5%), while those with traumatic tears were more balanced (51.4% female). This is consistent with other reports that show a higher percentage of males with traumatic injuries[37,38,40-42].

The average modified UCLA scale in this study was 33.7 in the non-traumatic group and 32.8 in the traumatic group. These results are similar to those found in the literature[37,38,43]. As a score of 28-33 points is considered good, the non-traumatic group had a slightly higher score than the traumatic group. We expected to find better functional outcomes in patients with traumatic rotator cuff repairs, as the healing capacity of these patients is higher. These results therefore disproved our hypothesis.

Rotator cuff repairs lead to improved muscle strength and range of motion compared with preoperative measurements[38,39,44,45]. This was one reason why we did not collect preoperative patient data. We observed that postoperative strength was reduced in the surgical shoulder compared with the unaffected side after a mean follow-up of 43 mo. Tear etiology did not impact strength recovery after rotator cuff repair compared with the uninjured limb.

Several factors influence the outcomes of rotator cuff repairs, including: Sex, duration of symptoms, and abduction and external rotation strength[23,46]. However, in our study we could not identify any variable that was predictive of functional outcome.

In the patients in our study with traumatic rotator cuff repairs, it was likely that many already had tendon degeneration, characterized by reduced cellular activity, collagen disorganization, fibroblast apoptosis and decreased extracellular matrix synthesis[29]. Chronic rotator cuff tears in older adults have a low healing potential and a high recurrence risk, even if treated surgically. This can be explained by degenerative changes in the tendon margin, even in cases with fatty infiltration below grade 2 on Goutallier scale. If these injuries had occurred in younger patients with acute and smaller injuries, the healing potential could be better because of low levels of apoptosis, fibrocartilaginous metaplasia and high rates of neoangiogenesis. The traumatic group could get better results in comparison with the non-traumatic group[28].

Braune *et al*[39] in 2003 compared range of motion and patient satisfaction after rotator cuff repairs after traumatic or non-traumatic tears. The traumatic group produced better postoperative results. However, in this study the average age was significantly lower in the traumatic group (mean 34.1 years) than in the non-traumatic (mean 54.1 years) group, as one of the inclusion criteria for the traumatic group was an age younger than 50 years.

The rotator cuff prevents degenerative processes, as it permits the formation of a closed joint space and participates in cartilage nutrition[47]. A hypothesis as to why our findings were equivocal between traumatic and non-traumatic tears is that patients with traumatic tears may wait a relatively long period of time to seek medical aid. A diagnostic failure in primary medical care[37] may also compromise treatment outcomes, as there may already be degenerative changes at the time of surgery. The late diagnosis of traumatic injuries can lead to surgical complications and poor results[37,38,44]. Compared with early repairs (< 3 wk), traumatic rotator cuff tears have better functional results compared with delayed repairs (> 3 wk). Late treatment is associated with reduced tendon elasticity, increased repair tension, muscle atrophy and fatty degeneration. Increased repair

tension leads to a lower rate of healing and decreased viscoelastic properties. Further, injuries resulting from trauma are large or massive (> 2 tendons)[37], which has a worse prognosis compared with minor injuries. Other authors[37,45] found that the outcomes of early repairs are better than late repairs, although exact time cutoffs have not been defined.

In our study we obtained good results in both groups as rated by the modified UCLA scale. These findings support arthroscopic rotator cuff repairs of either traumatic or non-traumatic injuries. Limitations to our study include: A small sample (n = 87), our muscle strength measurement method, and the use of only one functional score.

The functional results of the arthroscopic rotator cuff repair of traumatic tears are equivocal to those measured after non-traumatic tears. Both groups display adequate overall results.

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COMMENTS

Background

Rotator cuff injuries are the leading cause of shoulder pain, and can cause functional limitation and decreased quality of life. The causes of rotator cuff tears are multifactorial. It is believed that degeneration is essential, and most tears are slow and progressive. In contrast, acute tears can occur after trauma. The aim of this study is to compare shoulder functional outcomes after arthroscopic rotator cuff repair of traumatic and non-traumatic tears.

Research frontiers

Surgical treatment of rotator cuff tears is currently widely performed, since the prevalence of this disease is up to 39% in the population, increasing with age. The research hotspot is to evaluate the functional outcomes after arthroscopic rotator cuff repair in patients with traumatic and non-traumatic injuries. This may help to understand the post-surgical function of these patients, and support clinical decision making.

Innovations and breakthroughs

Chronic rotator cuff tears in older adults have a low healing potential and a high recurrence risk, even if treated surgically. Because of the higher healing capacity of patients with traumatic rotator cuff repairs, it was expected that this group of patients would have better functional outcomes. In previous data, traumatic tears had better postoperative results (range of motion and patient satisfaction) than non-traumatic tears, but the average age was significantly lower in the traumatic group than in the non-traumatic group, as one of the inclusion criteria for the traumatic group was an age younger than 50 years. In this study, the average age of the traumatic group was similar to the non-traumatic group, and the functional outcomes were similar in both groups. In this study, there was a higher percentage of males with traumatic injuries in comparison with non-traumatic injuries, and a good result in modified University of California, Los Angeles (UCLA) scale evaluation in both groups. These results are similar to those found in the literature.

Applications

The functional results of the arthroscopic rotator cuff repair are similar in traumatic and non-traumatic tears, with adequate overall results in both groups. These findings support arthroscopic rotator cuff repairs of either traumatic or non-traumatic injuries.

Terminology

The rotator cuff is a group of four tendons (subscapularis, supraspinatus, infraspinatus and teres minor) that cover the humeral head and plays an important role in the strength, mobility and stability of the shoulder by fixing the humeral head to the glenoid. The treatment for rotator cuff tears should be clinical or surgical. When surgical treatment is indicated, rotator cuff repairs can be performed through either arthroscopic or open approaches. Arthroscopic surgery is performed through micro incisions and preserves the deltoid muscle insertion.

Peer-review

The primary outcome was modified UCLA score validated for the Portuguese language, which takes into account pain, function, range of motion, strength and patient satisfaction.

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