



Original Article

Evaluation of the results from arthroscopic surgical treatment of rotator cuff injuries in patients aged 65 years and over[☆]



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ABSTRACT

Objectives: To evaluate the results from arthroscopic surgical treatment of rotator cuff injuries in patients aged 65 years and over.

Methods: Between 1998 and 2009, 168 patients underwent operations. Five cases were excluded. The remaining 163 patients were stratified according to their age group: 65–69 years (49.1%), 70–74 (26.4%) and 75 years and over (24.5%). Their mean age was 71 years (range: 65–83). There were 63 male patients (38.7%). The mean length of time with pain, from the onset of symptoms to the surgery, was 23 months (range: 2 days to 240 months). Sixty-two patients (38%) reported histories of trauma and 26 (16%) reported that their pain worsened through exertion.

Results: From the UCLA criteria, 80.4% of the results were excellent, 16% good, 1.8% fair and 1.8% poor. Complications occurred in 11%. The final clinical result did not show any correlation with age progression, injury size or tendons affected. However, there was a significant association ($p < 0.001$) between the presence of trauma and larger injuries. The length of time between the onset of symptoms and the surgical procedure had a significant relationship ($p < 0.027$) with the postoperative results: the longer this time was, the worse the results were.

Conclusion: Arthroscopic treatment of rotator cuff injuries in patients aged 65 years and over presented excellent and good results in 96.4% of the cases, according to the UCLA assessment, with a low complication rate. Advanced age did not show any influence on the postoperative clinical evolution, but the earlier the surgical treatment was instituted, the better the results were.

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Avaliação dos resultados do tratamento cirúrgico artroscópico das lesões do manguito rotador em pacientes com 65 anos ou mais

R E S U M O

Palavras-chave:
Manguito rotador
Artroscopia
Idoso

Objetivos: Avaliar os resultados do tratamento cirúrgico por via artroscópica nas lesões do manguito rotador (LMR) de pacientes com 65 anos ou mais.

Métodos: Entre 1998 e 2009 foram operados 168 pacientes. Cinco casos foram excluídos. Os 163 pacientes foram estratificados de acordo com a faixa etária de 65 a 69 (49,1%), 70 a 74 (26,4%) e acima de 75 (24,5%). A média foi de 71 anos (65 a 83). Eram do sexo masculino 63 pacientes (38,7%). A média de tempo de dor (início dos sintomas) até a cirurgia foi de 23 meses (2d–240 m). Referiram história de trauma 62 pacientes (38%) e 26 (16%) algum esforço com pioria da dor.

Resultados: Pelos critérios da Universidade da Califórnia em Los Angeles (UCLA) tivemos 80,4% de excelentes resultados, 16% bons, 1,8% regular e 1,8% ruim. Tivemos 11% de complicações. O resultado clínico final não mostrou correlação com a progressão da idade, o tamanho da lesão ou os tendões acometidos. Mas existe uma associação significativa ($p < 0,001$) entre a presença de trauma e lesões maiores. O tempo entre o início dos sintomas e o procedimento cirúrgico mostra uma relação significativa ($p < 0,027$) com os resultados pós-operatórios: quanto maior, piores os resultados.

Conclusão: O tratamento artroscópico da LMR em pacientes com 65 anos ou mais apresentou resultados excelentes e bons em 96,4% quando avaliados pelo UCLA, com baixa taxa de complicações. A idade avançada não demonstrou influência na evolução clínica pós-operatória. Entretanto, quanto mais precocemente o tratamento cirúrgico for instituído, melhores os resultados.

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Introduction

Rotator cuff injuries are very common in orthopedic practice, with prevalence between 5% and 33%. They frequently occur in the elderly population^{1,2,3,4} and reach 22% among patients over the age of 65 years.⁵ Individuals over the age of 50 years are more commonly affected by chronic injuries of greater severity as a result of the degenerative process, while the young population (<40 years) has injuries that are predominantly of traumatic etiology.^{1,6}

While some authors have demonstrated good results regarding improvement of pain, function and quality of life through conservative methods^{7,8} or through surgical treatment, including by means of acromioplasty and debridement alone,^{9,10} others have argued that surgical repair of rotator cuff injuries leads to better and longer-lasting results.^{2,3,4,11} Performing surgical procedures on elderly people may be a challenge. In 1995, Hatstrup and Scottsdale² suggested that patients aged 65 years or over present a significant chance of having larger lesions, which potentially adds difficulty to their repair. The bone quality is lower and this results in osteoporosis of the greater tubercle, subchondral cystic degeneration and irregularity of the cortical bone, and it may complicate anchor fixation. Furthermore, elderly people frequently present comorbidities (diabetes mellitus, rheumatoid arthritis or renal diseases), which may diminish the healing response and compromise surgical management.¹²

The long period between the initial presentation of symptoms and the time when arthroscopic surgical repair of the rotator cuff injury is performed is a negative prognostic factor for the clinical results.¹³ In addition, the size of the lesion, retraction, fatty degeneration and the quality of the tendon also influence the healing.^{14,15}

Some authors have believed that these patients' advanced age interferes with the healing of rotator cuff lesion suturing, such that young patients tend to have more favorable evolution. Nonetheless, arthroscopic repair on rotator cuff injuries in elderly people produces significant functional improvement and positive changes to quality of life,¹⁶⁻²⁰ with advantages in relation to open surgery and mini-open procedures, because of the small incision, absence of damage to the deltoid muscle, lower pain during the postoperative period and shorter hospital stay. Moreover, especially, it enables diagnosis and treatment of associated lesions through viewing the joint with minimal tissue trauma.²¹⁻²³ Thus, Charoussat et al.¹⁵ and Grondel et al.¹⁷ suggested that age alone is unrelated to poor results from injury repairs.

The present study had the objective of evaluating the results from arthroscopic surgical treatment of rotator cuff lesions in patients aged 65 years or over.

Sample and methods

A retrospective analysis was conducted on 168 shoulders in 163 patients aged 65 years or over who presented complete

tearing of the rotator cuff and underwent arthroscopic surgical treatment performed by the shoulder and elbow group of our service between September 1998 and August 2009.

The inclusion criteria were that the patients should be 65 years of age or over, with complete tearing of the rotator cuff that was arthroscopically sutured in an operation that took place at least 1 year earlier. The following were considered to be exclusion criteria: age of less than 65 years with either complete or incomplete tearing; open procedures; open procedures; and postoperative length of follow-up less than 1 year.

Out of the 168 shoulders evaluated, three were excluded due to loss from the follow-up and two because of death, for reasons unrelated to the treatment. The remaining 163 were stratified according to age, with division into three groups: 65–69 (49.1%); 70–74 (26.4%) and 75 or over (24.5%).

There were 63 male patients (38.7%) and 100 female patients (61.3%). Their mean age was 70 years and 10 months (range: 65–83). The length of time with pain, from the start of the symptoms until the surgical treatment ranged from 2 days to 240 months, with mean of 22 months and 25 days. The dominant side was affected in 108 cases (66.3%). Only 62 patients (38%) reported having histories of trauma, while 26 (16%) said that the start of their pain and its worsening were related to exertion of some type. Among the patients evaluated, 45 (27.6%) said that they practiced sports in which they used their upper limbs.

All the patients underwent the surgical procedure in the “deckchair” position, under general anesthesia in association with anesthetic block of the brachial plexus. We made an initial arthroscopic inspection of the joint and identified the associated lesions. Eighty-three patients (50.9%) presented lesions in the long head of the biceps brachii muscle. Among these, the tendon was absent in 17 cases (10.4%) and it was found to be adhering to the bicipital groove in two (1.2%). In the other cases in which we observed dislocation or injury affecting more than 50% of the diameter of the tendon of the long head of the biceps, we performed tenotomy (20 cases; 12.3%). We performed tenotomy in association with tenodesis in 44 cases (27%), before repairing the rotator cuff. We also found SLAP lesions (superior labrum, anterior and posterior) in four cases, Bankart lesions in three, calcareous tendinitis of the tendon of the supraspinatus muscle in one, adhesive capsulitis in two and shoulder arthrosis in 12 (Table 1). When the surgeon deemed it necessary, these lesions were treated during the same surgical procedure (Table 2).

Following this, we dealt with the subacromial space and performed bursal debridement and mobilization of the tendons. Acromioplasty was performed in 145 cases (89%) and resection of the distal portion of the clavicle (Mumford), which was indicated in the cases of pain in the acromioclavicular joint, was performed in 54 cases (33.1%). We then induced bleeding in the bone bed of the greater tubercle of the humerus and sutured the lesion. The number of tendon-to-tendon or tendon-to-bone stitches ranged from 1 to 12 (mean of 5). Suturing anchors were used in 158 cases, with a range from 1 to 5 (mean of 2).

The rotator cuff lesions were classified as small, found in 26 cases (16%); medium, 43 cases (26.4%); large, 25 cases (15.3%); or extensive, 69 cases (42.3%), in accordance with the classification of Hawkins.²⁴ Those that involved at least two tendons

Table 1 – Frequencies of lesions associated with rotator cuff injuries.

Associated lesions	No. of cases	%
LHB	83	50.9
SLAP lesion	4	2.5
Bankart lesion	3	1.8
CTSE	1	0.6
Adhesive capsulitis	2	1.2
Shoulder arthrosis	12	7.4
TOTAL	105	64.4

Source: Medical files of Irmandade Santa Casa de Misericórdia de São Paulo.

LHB, tendon of the long head of the biceps brachii muscle of the arm; CTSE, calcareous tendinitis of the tendon of the supraspinatus muscle.

were also considered to be extensive, as defined by Gerber et al.²⁵

From analysis on the tendons affected, 100% of the cases presented involvement of the tendon of the supraspinatus muscle; 43.6% the tendon of the infraspinatus muscle; and 33.1% the tendon of the subscapularis muscle.

After the operation, the patients were immobilized for 6–8 weeks by means of a functional sling. According to the size of the lesion and the retraction of the tendons, passive exercises such as pendulum exercises were allowed. If the lesion was extensive, the shoulder was kept immobilized for at least 4 weeks. Passive elevation was started in the fourth week and active elevation in the sixth week. Muscle strengthening exercises were only allowed starting 4 months after the operation.

The mean length of postoperative follow-up was 50 months and 18 days, with a range from 12 to 144 months. During this period, the patients were evaluated by means of the method of the University of California in Los Angeles (UCLA).²⁶

In the statistical analysis, the SPSS software (Statistical Package for the Social Sciences), version 17.0, was used to obtain the results, and 95% intervals were considered to be statistically significant ($p < 0.05$).

Results

The mean UCLA score among the 163 patients evaluated was 33.6 points (range: 11–35). 80.4% of the cases were considered to have attained excellent results, 16% were good and 3.6% were unsatisfactory: three fair and three poor.

The evaluation of the clinical results did not show any statistically significant correlation with age progression, such that we found that 97.6% of the results in the age group between 65 and 69 years were good or excellent; 95.4% between the ages of 70 and 74 years; and 95% aged 75 years or over ($p = 0.49$).

The size of the lesion did not show any statistically significant correlation with the postoperative clinical result ($p = 0.86$), or with age ($p = 0.67$). However, when associated with trauma, it was statistically significant. The larger lesions were generally associated with the presence of trauma ($p < 0.001$).

Table 2 – Treatment of lesions associated with rotator cuff injuries found during the surgical procedure.

Associated lesions	Debridement	Tenotomy	Tenodesis	Suture	Capsulotomy	Resection	Bone perforations
LHB	2	20	44				
SLAP lesion	3			1			
Bankart lesion				3			
CTSE					1		
Adhesive capsulitis					2		
Shoulder arthrosis	9						3
TOTAL	14	20	44	4	2	1	3

Source: Medical files of the institution.

LHB, tendon of the long head of the biceps brachii muscle of the arm; CTSE, calcareous tendinitis of the tendon of the supraspinatus muscle.

The tendon of the infraspinatus was affected in 43.6% of the cases and there was a slight increase in incidence with age progression ($p=0.31$).

The time that elapsed between the start of symptoms and the surgical procedure showed a statistically significant relationship ($p<0.027$) with the postoperative results, given that the greater the time that elapsed between the symptoms and the surgery was, the worse the final results were.

The incidence of complications was 6.1% (10 cases): one case of adhesive capsulitis, one of tendinitis of the biceps, two of limitation of range of motion regarding medial rotation, two of painful renewed tearing, two of non-painful renewed tearing with functional impotence, one of arthropathy of the rotator cuff and one of pain in the acromioclavicular joint.

Discussion

In the light of increasing longevity among the population and higher levels of physical activity, surgical repair of symptomatic lesions of the rotator cuff that do not present improvement through conservative treatment has come to be considered to be a treatment option for patients aged 65 years and over. Many forms of intervention have been advocated and there is some controversy regarding the type of surgical approach, i.e. whether to repair the lesion or just to perform debridement in isolation, among elderly patients. Some pioneering studies have demonstrated good results from subacromial decompression and arthroscopic debridement, which lead to temporary pain relief, but have inferior and less long-lasting results than lesion repair.^{6,9,10,27} Our findings from arthroscopic repair were good or excellent in 96.4% of the cases (157 shoulders) and were in line with some reports in the literature, in which repairs to rotator cuff lesions performed arthroscopically have been indicated as consistently better.^{3,4,11,20}

In 1995, Hatstrup and Scottsdale² found a clear association between the size of the lesion and the patient's age. The presence of large and extensive lesions was significantly greater among the older patients. Our study demonstrated this trend, since the incidence of extensive lesions was 37.5% among patients up to 69 years of age; 44.2% among those aged 70–74 years and 50% among those aged 75 years or over. The lesions found in elderly patients are generally of degenerative etiology, rather than of traumatic etiology; the musculature

is found to have atrophied and the tendons have become thinned and present poor quality for suturing (Figs. 1 and 2).

Although we did not find any studies in the literature correlating the size of the rotator cuff lesion with traumatic episodes, trauma was reported by 62 patients (38%) and was present in 12 cases of large lesions (19.4%) and 37 of extensive lesions (59.7%). Thus, this study presented a statistically significant correlation between histories of trauma and incidence of large and extensive lesions ($p<0.01$). There was also a slight increase in the incidence of such lesions in relation to age progression ($p=0.11$).

In an imaging study conducted by Boileau et al.,¹⁴ the healing rate for arthroscopically repaired lesions of the supraspinatus among 65 patients aged 29–79 years was 71%. Age was an influential factor, given that patients over the age of 65 years had a healing rate of 43% ($p=0.001$). Nonetheless, despite the tendency toward worse results among patients over the age of 65 years, which was also described by Hatstrup and Scottsdale,² Charousset et al.¹⁵ and Lam and Mok,¹⁸ our findings did not show any significant correlation between advancing age groups and the final functional clinical result.

Boileau et al.¹⁴ reported that the size of the lesion and delamination of the tendon of the infraspinatus and/or subscapular muscle significantly impaired healing subsequent to arthroscopic suturing ($p=0.02$). Charousset et al.¹⁵ also reported that the size of the lesion generally correlated with the prognosis. However, our study demonstrated that the size of the lesion was not related to the final results, and this finding was in line with that of Bittar,²⁸ who reported that 83% of the results from arthroscopic repair of extensive lesions in patients of mean age 67 years were satisfactory. It is also in agreement with the results from Gartsman et al.²¹ and Stollsteimer and Savoie,²⁹ who showed that all sizes of lesions could be treated arthroscopically, independent of age group. There were no differences between the results relating to small, medium-sized or large lesions.

Although Boileau et al.¹⁴ did not find any correlation between healing and the duration of preoperative pain, our study showed that the greater the time that elapsed between the start of pain and the surgery was, the worse the final functional results were, with statistical significance ($p=0.027$). The study by Lam and Mok¹⁸ also suggested that patients presenting symptoms for times longer than 34 months had a high likelihood of worse functional results through surgical treatment. Ellman et al.²⁶ and Flurin et al.¹³ reported that the longer the time interval between preoperative pain and surgery was,

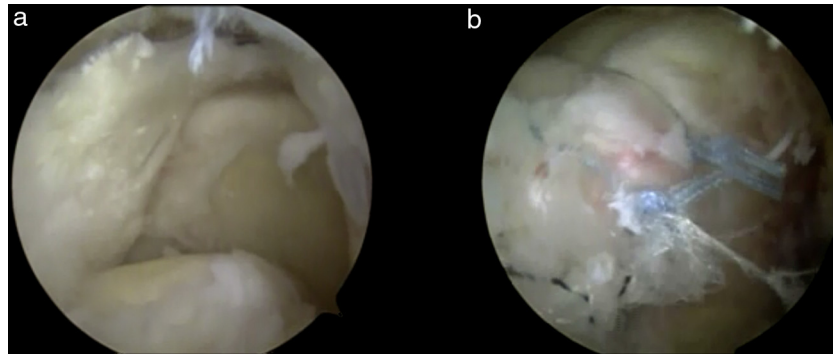


Fig. 1 – Intraoperative image of the right shoulder viewed through the posterior portal, showing: (A) lesion of the tendon of the supraspinatus and infraspinatus, which are greatly degenerated; (B) closure of the lesion using tendon-to-tendon stitches and anchors.

the larger the size of the lesion would be and, consequently, the more difficult it would be to repair it, with a worse prognosis.

The decision regarding which surgical technique to use (open, mini-open or totally arthroscopic) is generally based on the surgeon's preference and experience. In an analysis on the results obtained from arthroscopic repair of rotator cuff injuries, Checchia et al.²³ concluded that this technique is more efficient, both in relation to the results obtained (93.7% were excellent or good, according to the UCLA scores) and in relation to prevention of complications (9.2%). In relation to postoperative complications and treatment failures, our results are similar to those in the literature, with an incidence of 6.1%. In a review of 40 articles on the results from open repair of rotator cuff injuries conducted in 1997, Mansat et al.³⁰ found a complication rate of 10.5%. In 1992, Curtis et al.³¹ reported a complication rate of 4.8% from arthroscopic procedures and 8.8% from the mini-open technique. In contrast, in 1998, Berjano et al.³² reported rates of 10.6% from arthroscopic procedures and 5.3% from mini-open procedures. In 2001, Grondel et al.¹⁷ reported a complication rate of 6%, from analysis on extensive lesions repaired using the arthroscopic and mini-open techniques. On the other hand, from examination of 263 patients who underwent arthroscopic repair of rotator cuff lesions in 2007, Brislin et al.³³ reported a complication rate of 10.6% (28 cases). Joint stiffness occurred more frequently (23 cases) and this was unrelated to the extent of the lesion. In 2010, Verma et al.²⁰ also reported a similar

complication rate (7.7%) and stated that the complication rate was no greater among elderly individuals and therefore was unrelated to age progression.

Among our patients, we found one case of adhesive capsulitis, which underwent serial block of the suprascapular nerve, which led to remission of the condition (UCLA 34); one case of tendinitis of the biceps, which was treated using non-steroidal anti-inflammatory drugs (UCLA 35); two cases of limitation of the range of motion in medial rotation, which were treated by means of physiotherapy (UCLA 13 and 33, respectively); two cases of painful renewed tearing: the first underwent new surgical repair and evolved with UCLA 33 and the second was kept under expectant management, because of the patient's satisfaction (UCLA 29); two cases of non-painful renewed tearing with functional impotence, which were treated using physiotherapy, both with UCLA 33; one case of arthropathy of the rotator cuff, which underwent reverse shoulder arthroplasty (UCLA 34); and one case of pain in the acromioclavicular joint, which underwent corticoid infiltration and evolved with UCLA 35.

The incidence of dehiscence of suturing of rotator cuff injuries after open repair is around 13–68%.³⁴ Slabaugh et al.³⁵ reported that this rate is probably greater than what is cited in the literature, because most of these cases are asymptomatic and do not imply any pain or significant functional loss. In 2005, Ozbaydar et al.³⁶ used magnetic resonance imaging to evaluate fatty degeneration and recurrence of tearing of the rotator cuff subsequent to arthroscopic repair and

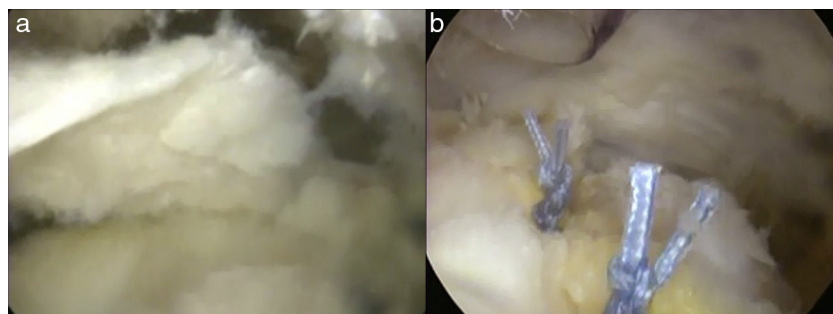


Fig. 2 – Intraoperative image of the right shoulder viewed through the posterior portal, showing: (A) thinning of the tendon of the supraspinatus; (B) closure of the lesion using anchors, at the border of the joint surface.

observed renewed tearing in 31.8%, even though 90.9% of the patients were satisfied. The extent of the fatty degeneration did not present any difference from before to after the operation. In 2010, Godinho et al.³⁷ evaluated the functional and anatomical results from arthroscopic surgical treatment of complete tearing of the rotator cuff in 100 patients of mean age 60 years, and investigated the correlation between ultrasound images and the Constant-Murley index. They found that there was no statistically valid correspondence between them. They reported that 67% of the shoulders studied presented excellent or good results, although 30% of them presented ultrasound reports showing renewed tearing. In our service, we did not routinely perform postoperative magnetic resonance imaging examinations. In our study, these examinations were requested for two symptomatic cases that showed dehiscence of the suture. Another two cases of asymptomatic dehiscence were observed in patients who had undergone the examination through requests from another service.

In our sample, we found four cases of dehiscence of the suture, but only two of these shown any symptoms.

All the rotator cuff lesions in our study were repaired completely, independently of the size of the lesion, or any retraction or fatty degeneration. In no case were subacromial decompression and debridement alone performed. Although we are aware that dehiscence of the suture probably occurs often, we believe that good results can be expected through this technique.

It is important to emphasize that our study had the largest sample in the literature relating to arthroscopic repair of rotator cuff lesions among this age group. However, this study presents limitations due to its retrospective nature, absence of a control group and short minimum follow-up of 12 months, although the maximum recovery is achieved by 6-9 months after the operation and from the twelfth month onwards, there are almost no further changes.²⁰ Another limitation was the lack of analysis on the degree of fatty degeneration of muscles, as described by Goutallier et al.,³⁸ given that not all the magnetic resonance examinations of our patients included T1 sagittal slices for complete analysis as described by Mellado et al.³⁹ in 2005.

Conclusion

Arthroscopic treatment of rotator cuff lesions in patients over the age of 65 years presents good or excellent results in 96.4%, when evaluated using the UCLA functional method, with a low complication rate.

Given that the objective of surgery is to improve pain and function, we believe that our study strongly suggests that indications for repairing rotator cuff injuries among elderly people are valid, considering that advanced age does not influence good postoperative clinical evolution. Likewise, the size of lesion is unrelated to the postoperative prognosis, even though large and extensive tearing is associated with the presence of trauma. We can also conclude that the earlier that the surgical treatment is implemented, the better the final functional results will be.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

1. Ellman H, Kay SP, Wirth M. Arthroscopic treatment of full-thickness rotator cuff tears: 2- to 7-year follow-up study. *Arthroscopy*. 1993;9(2):195-200.
2. Hattrup SJ, Scottsdale A. Rotator cuff repair: relevance of patient age. *J Shoulder Elb Surg Am*. 1995;4(2):95-100.
3. Melillo AS, Savoie FH, Field LD. Massive rotator cuff tears: debridement versus repair. *Orthop Clin N Am*. 1997;28(1):117-24.
4. Montgomery TJ, Yergler B, Savoie FH. Management of rotator cuff tears: a comparison of arthroscopic debridement and surgical repair. *J Shoulder Elb Surg Am*. 1994;3(2):70-8.
5. Fehring EV, Sun J, VanOeveren LS, Keller BK, Matsen FA. Full-thickness rotator cuff tear prevalence and correlation with function and co-morbidities in patients sixty-five years and older. *J Shoulder Elb Surg*. 2008;17(6):881-5.
6. Gartsman G. Massive, irreparable tears of the rotator cuff. Results of operative débridement and subacromial decompression. *J Bone Joint Surg Am*. 1997;79(5):715-21.
7. Itoi E, Tabata S. Conservative treatment of rotator cuff tears. *Clin Orthop Relat Res*. 1992;(275):165-73.
8. Ghroubi S, Chaari M, Elleuch H, Guermazi M, Baklouti S, Elleuch MH. Functional and quality of life outcome of none operated rotator cuff tears. *Ann Readapt Med Phys*. 2008;51(9):714-21.
9. Zvijac JE, Howard JL, Lemak LJ. Arthroscopic subacromial decompression in the treatment of full thickness rotator cuff tears: a 3 to 6 year follow-up. *Arthroscopy*. 1994;10(5):518-23.
10. Rockwood CA Jr, Williams G Jr, Burkhead WZ Jr. Débridement of degenerative, irreparable lesions of the rotator cuff. *J Bone Joint Surg Am*. 1995;77(6):857-66.
11. Weber SC. Arthroscopic debridement and acromioplasty versus mini-open repair in the management of significant partial-thickness tears of the rotator cuff. *Orthop Clin N Am*. 1997;28(1):79-82.
12. Brewer BJ. Aging of the rotator cuff. *Am J Sports Med*. 1979;7(2):102-10.
13. Flurin PH, Landreau P, Gregory T, Boileau P, Lafosse L, Guillo S, et al. Cuff integrity after arthroscopic rotator cuff repair: correlation with clinical results in 576 cases. *Arthroscopy*. 2007;23(4):340-6.
14. Boileau P, Brassart N, Wakinson DJ, Charles M, Hatzidakis AM, Krishnan SG. Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal? *J Bone Joint Surg Am*. 2005;87(6):1229-40.
15. Charousset C, Bellaiche L, Kalra K, Petrover D. Arthroscopic repair of full-thickness rotator cuff tears: is there tendon healing in patients aged 65 year or older? *Arthroscopy*. 2010;26(3):302-9.
16. Worland RL, Arredondo J, Angles F, Lopez-Jimenez F. Repair of massive rotator cuff tears in patients older than 70 years. *J Shoulder Elb Surg*. 1999;8(1):26-30.
17. Grondel RJ, Savoie FH, Field LD. Rotator cuff repairs in patients 62 years of age or older. *J Bone Joint Surg Am*. 2001;10(2):97-9.
18. Lam F, Mok D. Open repair of massive rotator cuff tears in patients aged sixty-five years or over: is it worthwhile? *J Shoulder Elb Surg*. 2004;13(5):517-21.
19. Rebuzzi E, Coletti N, Schiavetti S, Giusto F. Arthroscopic rotator cuff repair in patients older than 60 years. *Arthroscopy*. 2005;21(1):48-54.

20. Verma NN, Bathia S, Baker CL, Cole BJ, Nicholson GP, Romeo AA, et al. Outcomes of arthroscopic cuff repair in patients aged 70 years or older. *Arthroscopy*. 2010;26(10):1273-80.
21. Gartsman GM, Khan M, Hammerman SM. Arthroscopic repair of full-thickness tears of the rotator cuff. *J Bone Joint Surg Am*. 1998;80(6):832-40.
22. Burkhart SS. A stepwise approach to arthroscopic rotator cuff repair based on biomechanical principles. *Arthroscopy*. 2000;16(1):82-90.
23. Checchia SL, Santos PD, Miyazaki AN, Fregoneze M, Silva LA, Ishi M, et al. Avaliação dos resultados obtidos na avaliação artroscópica do manguito rotador. *Rev Bras Ortop*. 2005;40(5):229-38.
24. Hawkins RJ, Misamore GW, Hobeika PE. Surgery for full thickness rotator-cuff tears. *J Bone Joint Surg Am*. 1985;67(9):1349-55.
25. Gerber C, Fuchs B, Hodler J. The results of repair of massive tears of rotator cuff. *J Bone Joint Surg Am*. 2000;82(4):505-15.
26. Ellman H, Hanker G, Bayer M. Repair of the rotator cuff: end-result study of factors influencing reconstruction. *J Bone Joint Surg Am*. 1986;68(8):1136-44.
27. Kempf JF, Gleyze P, Bonnomet F, Walch G, Mole D, Frank A, et al. A multicenter study of 210 rotator cuff tears treated by arthroscopic acromioplasty. *Arthroscopy*. 1999;15(1):55-66.
28. Bittar ES. Arthroscopic management of massive rotator cuff tears. *Arthroscopy*. 2002;18(9 Suppl 2):104-6.
29. Stollsteimer GT, Savoie FH 3rd. Arthroscopic rotator cuff repair: current indications, limitations, techniques and results. *Instr Course Lect*. 1998;47:59-65.
30. Mansat P, Cofield RH, Kersten TE, Rowland CM. Complications of rotator cuff repair. *Orthop Clin N Am*. 1997;28(2):205-13.
31. Curtis AS, Snyder SJ, Del Pizzo W, Friedman MJ, Ferkel RD, Karzel RP. Complications of shoulder arthroscopy. *Arthroscopy*. 1992;8(3):395.
32. Berjano P, Gonzalez BG, Olmedo JF, Perez LA, Munilla MG. Complications in arthroscopic shoulder surgery. *Arthroscopy*. 1998;14(8):785-8.
33. Brislin KJ, Field LD, Savoie FH. Complications after arthroscopic rotator cuff repair. *Arthroscopy*. 2007;23(2):124-8.
34. Jost B, Pfirrmann CW, Gerber C, Switzerland Z. Clinical outcome after structural failure of the rotator cuff repairs. *Bone Joint Surg Am*. 2000;82(3):304-14.
35. Slabaugh MA, Nho SJ, Grumet RC, Wilson JB, Romeo AA, Verma NN, et al. Does the literature confirm superior clinical results in radiographically healed rotator cuffs after rotator cuff repair? *Arthroscopy*. 2010;26(3):393-403.
36. Ozbaydar MU, Tonbul M, Yalaman O. The results of arthroscopic repair of full-thickness tears of the rotator cuff. *Acta Orthop Traumatol Turc*. 2005;39(2):114-20.
37. Godinho GG, França FO, Freitas JMA, Watanabe FN, Nobre LO, Almeida Neto MA, et al. Avaliação da integridade anatômica por exame de ultrassom e funcional pelo índice de Constant & Murley do manguito rotador após reparo artroscópico. *Rev Bras Ortop*. 2010;45(2):174-80.
38. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures - pre and postoperative evaluation by CT scan. *Clin Orthop Relat Res*. 1994;(304):78-83.
39. Mellado JM, Calmet J, Olona M, Esteve C, Camins A, Palomar LP, et al. Surgically repaired massive rotator cuff tears: MRI of tendon integrity, muscle fatty degeneration, and muscle atrophy correlated with intraoperative and clinical findings. *AJR Am J Roentgenol*. 2005;184(5):1456-63.