MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2015; 21: 1556-1561
DOI: 10.12659/MSM.893058

Received: 2014.11.17
Accepted: 2014.12.15
Published: 2015.05.28

Single-Versus Double-Row Arthroscopic Rotator Cuff Repair in Massive Tears

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABE 1 EnZhi Wang
BC 1 Liang Wang
DF 1 Peng Gao
CD 1 ZhongJi Li
EF 1 Xiao Zhou
ABG 2 SongGang Wang

1 Department of Orthopaedic Surgery, People's Hospital of Zhangqiu, Zhangqiu, Shandong, P.R. China
2 Department of Orthopaedic Surgery, Qilu Hospital of Shandong University, Jinan, Shandong, P.R. China

Corresponding Author: SongGang Wang, e-mail: sgangwjn@163.com
Source of support: Departmental sources

Background: It is a challenge for orthopaedic surgeons to treat massive rotator cuff tears. The optimal management of massive rotator cuff tears remains controversial. Therefore, the goal of this study was to compare arthroscopic single- versus double-row rotator cuff repair with a larger sample size.

Material/Methods: Of the subjects with massive rotator cuff tears, 146 were treated using single-row repair, and 102 were treated using double-row repair. Pre- and postoperative functional outcomes and radiographic images were collected. The clinical outcomes were evaluated for a minimum of 2 years.

Results: No significant differences were shown between the groups in terms of functional outcomes. Regarding the integrity of the tendon, a lower rate of post-treatment retear was observed in patients who underwent double-row repair compared with single-row repair.

Conclusions: The results suggest that double-row repair is relatively superior in shoulder ROM and the strength of tendon compared with single-row repair. Future studies involving more patients in better-designed randomized controlled trials will be required.

MeSH Keywords: Arthroscopy • Outcome Assessment (Health Care) • Rotator Cuff

Full-text PDF: http://www.medscimonit.com/abstract/index/idArt/893058

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Background

Arthroscopic techniques and instrumentation have developed rapidly and various techniques have been introduced for the treatment of rotator cuff tears. Due to decreased short-term pain and a somewhat cosmetic effect, arthroscopic repair is more popular than open repair [1–3].

Maintaining the integrity of the tendon is the primary goal of rotator cuff repair management strategies. Most studies have also shown improved clinical outcomes after repair, and small and medium-sized rotator cuff tears have been commendably performed with any repair management strategy in most cases. Recently, biomechanical studies have shown that the double-row repair procedure is superior for improving the pressurized contact area and the mean pressure between the tendon and footprint compared with the single-row repair procedure [4,5].

However, there is still controversy regarding the optimal management of massive rotator cuff tears (MRCTs) [6–8]. MRCTs are those in which the length of the greatest diameter of the tear measures more than 5 cm [9] or those that involve at least 2 tendons [10]. Charousset et al. [11] reported better tendon healing rates with double-row repairs compared with single-row repairs but did not observe any significant difference in the clinical results. However, a recent comparative study [12] showed significantly greater functional outcomes in patients with large-to-massive tears that were treated with double-row repair compared with single-row repair. The sample size and duration of follow-up were the limitations of these studies. Due to these limitations, there may be a lack of strong evidence showing that either single- or double-row repair is superior.

Because of the controversy described above, we performed this study to address the question of whether double-row repair gives results that are superior to those obtained using single-row repair in terms of the integrity of the tendon and clinical outcomes for the treatment of MRCTs with a large sample size.

Material and Methods

This study was approved by our Institutional Review Board. From 2006 to 2012, 1137 patients underwent arthroscopic repair of rotator cuff tears. A total of 248 patients were included in the study. Single-row repair was performed in 146 patients, and double-row repair was used in 102 patients. The inclusion criteria were as follows: (1) a massive rotator cuff tear with preoperative magnetic resonance imaging (MRI) and arthroscopic evidence; (2) which persisted through non-operative treatment for more than 3 months with poor outcome; and (3) no previous history of fractures or operations on the affected shoulder. Patients were excluded if they had the following: (1) rotator cuff tears less than a diameter of 5 cm; (2) ipsilateral shoulder pathology; (3) glenohumeral osteoarthritis detected on radiographs; (4) a follow-up of less than 24 months; and (5) an inability to answer the questionnaires or undergo the rehabilitation treatment.

Clinical evaluations were conducted on all patients preoperatively and 2 years postoperatively. The data were collected by an orthopaedic surgeon using the VAS, range of motion (ROM), the Constant score, the American Shoulder and Elbow Surgeons (ASES) score, and the University of California, Los Angeles (UCLA) score. All patients underwent a radiographic evaluation consisting of anteroposterior (AP) views of the internal and external rotation and MRI images. All films were assessed by two specialists in musculoskeletal radiology. The size of the tear and fatty degeneration in the anteroposterior dimension were recorded. The postoperative images were used to divide the extent of rotator cuff injury into three classes: (1) full-thickness tear, (2) partial-thickness tear, and (3) cuff integrity.

All operations were carried out by a single experienced surgeon. The patients underwent general anaesthesia and were placed on the beach chair position. The arm was drawn at approximately 30–45° of abduction and 20° of forward flexion. Standard anterior and posterior portals were performed, and then a diagnostic arthroscopy was conducted to evaluate the quality of muscle tendon and arthrodial cartilage in shoulder.

In the single-row repairs method, anchors (Bio-Corkscrew, Arthrex, Naples, FL, USA) were placed along the lateral edge of the greater tuberosity within the footprint of the rotator cuff through the superior portal region. Sutures were then individually passed from the double-loaded anchors into the lateral edge of the tendon. If it was necessary to place a simple suture, a ten- to 15-mm bite of tissue was sutured using an antegrade suture passer or other instruments. After the sutures had been placed, they were sequentially tied with the help of a locking, sliding knot with backup half hitches.

For double-row repairs, anchors for the medial row were set at the lateral margin of the articular surface. A lateral row of anchors was then inserted in the lateral aspect of the footprint, slightly distal to the greater tuberosity. Both sutures were passed through the tendon and tied in a mattress fashion using a locking, sliding knot with back-up half-hitches.

The same postoperative rehabilitation protocol was used in the two groups. An immobilizing abduction brace was applied and passive range of motion stretching exercises were carried out. Shortly thereafter, at postoperative week 6, active-assisted range of motion exercises were started. Light activities were allowed at 3 months after surgery. Sports exercises and heavy labor were permitted after 9 months.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Table 1. Patient demographics and combined surgical procedures.

Variable	Single-row group	Double-row group	*P* value
Sample size (n)	146	102	
Age (mean ±SD, years)	57.2±6.3	58.4±5.9	
Gender (f/m)	56/38	39/29	.777
Affected shoulder (l/r)	46/43	32/36	.566
Mean area (mm^2)	41.2±7.2	39.9±9.5	.569
Workers' compensation (n)	2	2	.742
Concomitant procedures (n)			
Biceps tenotomy	5	4	.877
Biceps tenodesis	7	5	.982
Acromioplasty	8	6	.944
Distal clavicle resection	1	0	.394
Preoperative VAS	6.7±1.7	6.4±1.9	.292
Preoperative constant	51.6±13.5	52.7±12.8	.601
Preoperative ASES	49.4±11.6	50.3±10.9	.617
Preoperative UCLA score	18.8±4.8	19.4±5.1	.445
Range of motion			
Forward flexion (deg)	124.4±36.7	125.1±34.5	.903
External rotation (deg)	36.2±16.8	35.9±14.2	.807

f – female; m – male; l – left; r – right; VAS – Visual Analogue Score; ASES – American Shoulder and Elbow Surgeons; UCLA – University of California, Los Angeles.

All statistical analyses were performed using the SPSS version 15.0 software. The 2-tailed, unpaired *t* test was used to evaluate differences between two groups, and the 2-tailed, paired *t* test was used to detect changes in preoperative to postoperative outcome scores. Student's *t* test was used to compare the differences for continuous data in terms of preoperative and postoperative VAS, UCLA score, Constant score, ASES index score, time of ability to activities, and ROM in both groups. Categorical data were analyzed with the chi-square test. The significance level was set at $P<0.05$.

Results

The demographic data are presented in Table 1. The single-row repair technique was performed in146 patients, and double-row repair was performed in 102 patients. In both groups, there were no significant differences in the pre-surgical values with regards to age, gender, affected shoulder, workers' compensation, ROM and scales (VAS, UCLA, ASES and Constant).

All of the results at the final follow-up in both groups showed a significant improvement compared with the patients' preoperative status. There were no significant differences between the groups at the final follow-up evaluation in terms of VAS (P=0. 082), ASES index (P=0.779), Constant (P=0.899), and UCLA (P=0.895) (Table 2).

Comparing the ability to participate in activities, the single-row repair procedure showed superior results compared with the double-row repair technique in both daily and sports activities (P=0.019; P=0.006) (Table 2). Comparing the ROM (Table 2), there were no significant differences in forward flexion (162.5±8.6° in single-row group and 171.7±9.5° in double-row group; P=0.093) and external rotation (48.8±12.6° in single-row group and 53.4±11.2° in double-row group; P=0. 171). However, the double-row repair technique showed a tendency towards better results in ROM compared with the single-row repair technique.

The retear rate of a repaired rotator cuff was 29% (43/146 shoulders) for single-row repair and 17% (17/102 shoulders) for double-row repair, and this difference was statistically significant ($P<0.05$) (Table 3). The 43 retears in the single-row repair group involved 35 partial-thickness tears and 8 full-thickness tears. The 17 retears in the double-row repair group involved 12 partial-thickness tears and 5 full-thickness tears.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Table 2. Clinical outcomes at the final follow-up.

	Single-row group	Double-row group	P value
Preoperative VAS	1.9±1.4	2.2±0.9	.082
Preoperative constant	82.3±13.6	84.2±9.8	.779
Preoperative ASES	86.5±10.1	87.1±8.9	.899
Preoperative UCLA	30.6±5.8	31.4±4.6	.895
Time of daily activities (m)	5.2±1.1	5.8±2.1	.019
Time of sports activities (m)	9.3±1.8	10.2±2.4	.006
Range of motion			
Forward flexion (deg)	162.5±8.6	171.7±9.5	.093
External rotation (deg)	48.8±12.6	53.4±11.2	.171

VAS – Visual Analogue Score; ASES – American Shoulder and Elbow Surgeons; UCLA – University of California, Los Angeles; m – months; deg – degree.

Table 3. Retear rate of single-row and double-row repairs in each group.

	Single-row group	Double-row group	P value
Intact	103	85	.021
Retear	43	17	

Discussion

The most important findings were the lower retear rate but later return to daily and sports activities in the double-row group compared with the single-row repair group, although no significant differences were found in the functional outcomes of the two groups.

Massive rotator cuff tears present a particularly complex and difficult challenge for the orthopaedic surgeon. Several published studies on both open and arthroscopic approaches have reported improved results in shoulder function and pain relief with rotator cuff repair [9,11,13,14]. Arthroscopic rotator cuff repairs are becoming popular as a result of improvements in technology and the ability to achieve robust repairs in a minimally invasive fashion [15]. Compared with repairs of smaller tears, the operative repair of massive tears is technically more difficult and is associated with a higher recurrence rate [16–20]. Poor results for the treatment of the MRCTs are primarily due to inelastic and poor tendon quality, scarring and adhesions to the retracted tendon, muscle atrophy, and fatty infiltration [21–25]. Many techniques have been introduced for the treatment of MRCTs [26–28]. However, so far, no articles have been published that definitely support the superior clinical outcomes of double-row fixation over single-row fixation. We conducted this study to confirm, in a large sample population, whether double-row repairs could yield better results compared with single-row repairs for the treatment of MRCTs.

Biomechanical studies have emphasized that the double-row repair technique yields results that are superior to the single-row repair technique [29–31]. However, clinical studies have not yet verified this idea [32–35]. The results of this study suggested that the functional outcomes both single- and double-row repairs are equal with respect to VAS, UCLA, ASES and Constant score. A previous study by Sugaya et al. [36] also showed no significant difference between the groups in terms of two postoperative scores. However, Sugaya et al. thought that the dual-row repairs excelled in terms of structural outcome compared with the single-row technique. Carbonel et al. [26] reported that a significant improvement with the double-row technique was demonstrated in clinical evaluation and that the improvements were more significant in tears greater than 30-mm than in ten- to 30-mm tears. Charousset et al. [11] performed a non-randomized comparative study including 31 patients in the double-row group and 35 in the single-row group. There were no significant differences between the groups in the clinical outcomes measured by the Constant scale. However, in these studies, the limitation of the period of follow-up remains; therefore, long-term follow-up is required in future studies.

In the study by Carbonel et al. [26], the double-row technique showed superior results in ROM compared with the single-row technique. Franceschi et al. [32] published a series of 60 patients who underwent single- or double-row repair. With a mean period of 24 months of follow-up, MRI showed no significant

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

difference in the postoperative ROM between the groups. In this study, the ROM results also exhibited no difference when comparing single-row repair with double-row repair. However, a tendency for a larger ROM was shown in the double-row repair group. Stiffness is the most common complication after rotator cuff repair [37,38]. However, a standard rehabilitation protocol for tendon healing, though it prevents shoulder stiffness, has not been definitively established. This is an issue that requires careful judgment because overly conservative measures tend to aggravate stiffness, whereas overly aggressive measures can result in recurrent tears [39].

A few studies have shown that the results are variable in massive tears, which have retear rates of 17% to 44% [40–42]. Several studies have reported superior tendon strength in patients who had undergone double-row repair [43,44]. However, because these studies represent a heterogeneous series of operative techniques and tear sizes, it is not possible to reach a consistent conclusion. The failure rate on MRI in this study was 24.4%, representing a total of 60 patients. Compared with single-row repair, double-row repair resulted in a stronger rotator cuff postoperation. These findings were in line with the results comparing the biomechanical properties of the two techniques. Therefore, we can conclude, with caution, that double-row repair could significantly decrease the retear rates compared with single-row repair.

Our study has some inherent limitations. First, this study was not designed as a randomized trial because these techniques were applied at different time points. Next, though we tried to include a large sample size, this study had low power for recognizing differences in the clinical scores between the repair procedures. Finally, because the choice of surgical procedure was made according to the surgeon's preference at the time of surgery, some bias may have existed in the selection of the repair technique.

Conclusions

Single- and double-row repairs resulted in significant improvement in shoulder functions. No differences in functional outcomes were shown between the groups. Although single-row repair resulted in the ability of patients to take part in activities at a shorter time after the procedure, the results with regards to ROM and the strength of tendon appeared superior following double-row repair. To better evaluate the outcomes of the two treatment strategies, a well-designed randomized controlled trial is warranted.

Competing interests

The authors declare that they have no competing interests.

Acknowledgement

We would like to thank Qing Wu for collecting the clinical data.

References:

1. Gartsman GM. Arthroscopic management of rotator cuff disease. J Am Acad Orthop Surg, 1998; 6: 259–66
2. Lindley K, Jones GL: Outcomes of arthroscopic versus open rotator cuff repair: a systematic review of the literature. Am J Orthop (Belle Mead NJ), 2010; 39: 592–600
3. van der Zwaal P, Thomassen BJ, Nieuwenhuijse MJ et al: Clinical outcome in all-arthroscopic versus mini-open rotator cuff repair in small to medium-sized tears: a randomized controlled trial in 100 patients with 1-year follow-up. Arthroscopy, 2013; 29: 266–73
4. Nho SJ, Delos D, Yadav H et al: Biomechanical and biologic augmentation for the treatment of massive rotator cuff tears. Am J Sports Med, 2010; 38: 619–29
5. Nho SJ, Slabaugh MA, Seroyer ST et al: Does the literature support double-row suture anchor fixation for arthroscopic rotator cuff repair? A systematic review comparing double-row and single-row suture anchor configuration. Arthroscopy, 2009; 25: 1319–28
6. Frankle M, Siegal S, Pupello D et al: The Reverse Shoulder Prosthesis for glenohumeral arthritis associated with severe rotator cuff deficiency. A minimum two-year follow-up study of sixty patients. J Bone Joint Surg Am, 2005; 87: 1697–705
7. Gerber C, Maquieira G, Espinosa N: Latissimus dorsi transfer for the treatment of irreparable rotator cuff tears. J Bone Joint Surg Am, 2006; 88: 113–20
8. Sanchez-Sotelo J, Cofield RH, Rowland CM: Shoulder hemiarthroplasty for glenohumeral arthritis associated with severe rotator cuff deficiency. J Bone Joint Surg Am, 2001; 83-A: 1814–22
9. DeOrio JK, Cofield RH: Results of a second attempt at surgical repair of a failed initial rotator-cuff repair. J Bone Joint Surg Am, 1984; 66: 563–67
10. Gerber C, Fuchs B, Hodler J: The results of repair of massive tears of the rotator cuff. J Bone Joint Surg Am, 2000; 82: 505–15
11. Charousset C, Grimberg J, Duranthon LD et al: Can a double-row anchorage technique improve tendon healing in arthroscopic rotator cuff repair?: A prospective, nonrandomized, comparative study of double-row and single-row anchorage techniques with computed tomographic arthrography tendon healing assessment. Am J Sports Med, 2007; 35: 1247–53
12. Park JY, Lhee SH, Choi JH et al: Comparison of the clinical outcomes of single- and double-row repairs in rotator cuff tears. Am J Sports Med, 2008; 36: 1310–16
13. Bennett WF: Arthroscopic repair of massive rotator cuff tears: a prospective cohort with 2- to 4-year follow-up. Arthroscopy, 2003; 19: 380–90
14. Bynum CK, Lee S, Mahar A et al: Failure mode of suture anchors as a function of insertion depth. Am J Sports Med, 2005; 33: 1030–34
15. Sheibani-Rad S, Giveans MR, Arnoczky SP, Bedi A: Arthroscopic single-row versus double-row rotator cuff repair: a meta-analysis of the randomized clinical trials. Arthroscopy, 2013; 29: 343–48
16. Aurora A, McCarron J, Iannotti JP, Derwin K: Commercially available extracellular matrix materials for rotator cuff repairs: state of the art and future trends. J Shoulder Elbow Surg, 2007; 16: S171–78
17. Lu XW, Verborgt O, Gazielly DF: Long-term outcomes after deltoid muscular flap transfer for irreparable rotator cuff tears. J Shoulder Elbow Surg, 2008; 17: 732–37
18. Gazielly DF, Gleyze P, Montagnon C: Functional and anatomical results after rotator cuff repair. Clin Orthop Relat Res, 1994: (304): 43–53

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

19. Harryman DT II, Hettrich CM, Smith KL et al: A prospective multipractice investigation of patients with full-thickness rotator cuff tears: the importance of comorbidities, practice, and other covariables on self-assessed shoulder function and health status. J Bone Joint Surg Am, 2003; 85-A: 690–96
20. Harryman DT II, Mack LA, Wang KY et al: Repairs of the rotator cuff. Correlation of functional results with integrity of the cuff. J Bone Joint Surg Am, 1991; 73: 982–89
21. Goutallier D, Postel JM, Bernageau J et al: Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Relat Res, 1994: (304): 78–83
22. Goutallier D, Postel JM, Gleyze P et al: Influence of cuff muscle fatty degeneration on anatomic and functional outcomes after simple suture of full-thickness tears. J Shoulder Elbow Surg, 2003; 12: 550–54
23. Goutallier D, Postel JM, Van Driessche S et al: Tension-free cuff repairs with excision of macroscopic tendon lesions and muscular advancement: results in a prospective series with limited fatty muscular degeneration. J Shoulder Elbow Surg, 2006; 15: 164–72
24. Goutallier D, Postel JM, Radier C et al: Long-term functional and structural outcome in patients with intact repairs 1 year after open transosseous rotator cuff repair. J Shoulder Elbow Surg, 2009; 18: 521–28
25. Zingg PO, Jost B, Sukthankar A et al: Clinical and structural outcomes of nonoperative management of massive rotator cuff tears. J Bone Joint Surg Am, 2007; 89: 1928–34
26. Carbonel I, Martinez AA, Calvo A et al: Single-row versus double-row arthroscopic repair in the treatment of rotator cuff tears: a prospective randomized clinical study. Int Orthop, 2012; 36: 1877–83
27. Kim YK, Moon SH, Cho SH: Treatment outcomes of single- versus double-row repair for larger than medium-sized rotator cuff tears: the effect of preoperative remnant tendon length. Am J Sports Med, 2013; 41: 2270–77
28. Carbonel I, Martinez AA, Aldea E et al: Outcome and structural integrity of rotator cuff after arthroscopic treatment of large and massive tears with double row technique: a 2-year followup. Adv Orthop, 2013; 2013: 914148
29. Kim DH, Elattrache NS, Tibone JE et al: Biomechanical comparison of a single-row versus double-row suture anchor technique for rotator cuff repair. Am J Sports Med, 2006; 34: 407–14
30. Meier SW, Meier JD: The effect of double-row fixation on initial repair strength in rotator cuff repair: a biomechanical study. Arthroscopy, 2006; 22: 1168–73
31. Smith CD, Alexander S, Hill AM et al: A biomechanical comparison of single and double-row fixation in arthroscopic rotator cuff repair. J Bone Joint Surg Am, 2006; 88: 2425–31
32. Franceschi F, Ruzzini L, Longo UG et al: Equivalent clinical results of arthroscopic single-row and double-row suture anchor repair for rotator cuff tears: a randomized controlled trial. Am J Sports Med, 2007; 35: 1254–60
33. Papalia R, Franceschi F, Del Buono A et al: Double row repair: is it worth the hassle? Sports Med Arthrosc, 2011; 19: 342–47
34. Pennington WT, Gibbons DJ, Bartz BA et al: Comparative analysis of single-row versus double-row repair of rotator cuff tears. Arthroscopy, 2010; 26: 1419–26
35. Reardon DJ, Maffulli N: Clinical evidence shows no difference between single- and double-row repair for rotator cuff tears. Arthroscopy, 2007; 23: 670–73
36. Sugaya H, Maeda K, Matsuki K, Moriishi J: Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: single-row versus dual-row fixation. Arthroscopy, 2005; 21: 1307–16
37. Brislin KJ, Field LD, Savoie FH III: Complications after arthroscopic rotator cuff repair. Arthroscopy, 2007; 23: 124–28
38. Hafez MA, Al-Dars AM: Glass foreign bodies inside the knee joint following intra-articular injection. Am J Case Rep, 2012; 13: 238–40
39. Koo SS, Burkhart SS: Rehabilitation following arthroscopic rotator cuff repair. Clin Sports Med, 2010; 29: 203–11, vii
40. Huijsmans PE, Pritchard MP, Berghs BM et al: Arthroscopic rotator cuff repair with double-row fixation. J Bone Joint Surg Am, 2007; 89: 1248–57
41. Sugaya H, Maeda K, Matsuki K, Moriishi J: Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair. A prospective outcome study. J Bone Joint Surg Am, 2007; 89: 953–60
42. Li R, Guo G, Chen B, Zhu L, Lin A: Arthroscopically-assisted reduction and fixation of an old osteochondral fracture of the lateral femoral condyle. Med Sci Monit, 2012; 18(12): CS117–20
43. Anderson K, Boothby M, Aschenbrener D, van Holsbeeck M: Outcome and structural integrity after arthroscopic rotator cuff repair using 2 rows of fixation: minimum 2-year follow-up. Am J Sports Med, 2006; 34: 1899–905
44. Cole BJ, McCarty LP III, Kang RW et al: Arthroscopic rotator cuff repair: prospective functional outcome and repair integrity at minimum 2-year follow-up. J Shoulder Elbow Surg, 2007; 16: 579–85

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]