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Mid-term functional and structural analysis arthroscopic single-row repair in full thickness rotator cuff tear

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ABSTRACT

Background: Purpose is to analyse functional scores and structural integration of cuff in Full thickness cuff tear patients treated with single row Arthroscopic rotator cuff repair (SR-ARCR) making it cost effective surgery in developing countries. Additionally, evaluation of Fatty atrophy, Glenohumeral arthritis, importance of subscapularis repair and role of biceps tenotomy was done.
Methods: 60 rotator cuff repairs with minimum 12 months follow-up and all treated by SR-ARCR. Functional Assessment by Constant Murley Score (CMS), UCLA score and structural assessment by Sugaya grading.
Results: Mean follow-up 35.93± 26.24 months with post operative mean constant murley (CMS) was 94.83±7.78 ($p<0.001$), mean UCLA 33.82±6.7 ($p<0.001$). Active forward flexion (AFF) 166.5±11.62($p<0.001$), External rotation 79.17±10.13 ($p<0.001$), Muscle strength (0-25) 22.78±3.32($p<0.001$), VAS 1.2±0.75($p<0.001$), restoration of Acromio-humeral-distance (AHD) to 8.8±1.79($p<0.001$). Sugaya 1(85%) having CMS 97.06±5.21 ($p<0.001$), Sugaya 2(10%) having CMS 82.67±9.42($p<0.001$), Sugaya 3 (5%) having 81.33±6.35 ($p<0.001$).
Conclusion: Single row arthroscopic rotator cuff repair offers excellent outcomes cost effectively by reducing number of anchors and with supervised physiotherapy and rehabilitation protocols. Good structural integration of rotator cuff ensures better functional outcomes. Repair of Subscapularis to balance force couple, biceps tenotomy to decrease pain and medialised repair to decrease tension of repaired cuff improves functional scores. Restoration of acromio-humeral-distance decreases progression of gleno-humeral arthritis.

Keywords: Single row repair, Arthroscopic rotator cuff, Sugaya grading, Constant murley score, Cost effective

INTRODUCTION

Shoulder pain, muscle weakness and altered glenohumeral kinematics is frequently seen in cuff tear patients. 4% to 32% of the population are symptomatic and incidence increases with age. Non-surgical management can be offered in initial phase.[1] Shoulders with intact repairs do appear to have substantially better functional results than those with recurrent tears.[2] In comparison to open rotator cuff repair, arthroscopic repair has become the first choice for treating cuff due to its shorter hospitalization, reduced postoperative pain, faster recovery, and better cosmetic results.[3] Over the last few years, progression from single-row (SR) to double-row (DR) and trans osseous equivalent (TOE) techniques , promoted by some surgeons to restore the anatomic rotator cuff footprint and maximize tendon bone contact area are without any significant clinical and functional benefits over single row repair.

Purpose is to evaluate clinical, functional and structural outcomes in population who underwent single row Arthroscopic rotator cuff repair (ARCR) which can be executed consistently and effectively in lesser cost. We hypothesize that arthroscopic single row rotator cuff repair offers good clinical, functional and structural integrity results in a cost-effective manner. Additionally, evaluation

of fatty atrophy, glenohumeral arthritis, retraction of tear, importance of subscapularis repair and role of biceps tenotomy is done.

METHODS

A retrospective monocentric study (Level 4 evidence) was conducted with prospective data collection on 60 cases who underwent single-row ARCR between July 2016 and January 2023 with a minimum 1-year follow-up in Vaishvi Hospital, Vadodara. Local ethical committee approval (IECBHR) was taken before the study began and informed consent was obtained from all participants. Clinical examination and radiological investigations done for all the patients. Neer's impingement test and Hawkins-Kennedy tests were conducted to assess for impingement, along with the Yergason and Speed tests for the biceps. The empty can test, the Jobe test, the Hornblower test, the Resistive external rotation test, the belly press test, and the Lift-off test were conducted for each patient.

The acromio-humeral distance was measured using the true AP view. Clinical findings were confirmed through MRI. Tear Retraction, tear size, fatty infiltration recorded and graded accordingly .14 patients who could not come for follow-up did not participate in the study. The collected data comprised the patient's age, gender, months of follow-up, related procedures, Constant score, University of California, Los Angeles (UCLA) score, simple shoulder test score, and VAS score during pre- and post-operative phases. All patients (n= 60) underwent surgery in a beach chair position (80-degree incline) under general anaesthesia, supplemented with an interscalene block for pain relief after the procedure. Systolic blood pressure was maintained within the range of 80-100 mmHg throughout the surgical operation. All standard portals were taken.

Intraoperative measurement of tear done by probe. The subacromial space was assessed through a posterolateral portal, and bursectomy with decompression was conducted in all cases. Adhesions were removed, allowing the cuff to move freely. The cancellous bone bed was created using a motorized shaver system. The edges of the torn cuff were revitalized using duckbill forceps and a motorized shaver system. Double loaded 5/6.5 mm titanium suture anchor or triple loaded 5.5 mm titanium suture anchor/bioabsorbable helicoil/PEEK anchors featuring non-absorbable braided material used.

2 anchors were used for Supraspinatus and Infraspinatus tear and 3rd anchors used if Subscapularis was torn as well. The cuff was fixed using the Duncan knot method.

The final observation was made via the subacromial space to ensure full coverage of the humeral head with the rotator cuff. Biceps tenotomy was performed when inflamed and Rug sign was positive. Medializing the anatomic footprint to a maximum of 8 mm or margin conversion suture was attempted in situations where tension-free repair could not be achieved. Complete rotator cuff repairs done in all cases.

Inclusion criteria

The inclusion criteria are traumatic or degenerative tears. Failed conservative treatment. Full thickness rotator cuff tear. Participation in follow-up for a minimum of 12 months.

Exclusion criteria

The exclusion criteria are irreparable full-thickness tears, partial rotator cuff tear, revision surgery or prior shoulder surgery, neurological disorders.

Post-operative rehabilitation protocol

The shoulder rehabilitation protocol following rotator cuff repair focused on early dynamic glenohumeral mobility and the recovery of cuff strength. During the program, excessive strain on the tissues was prevented, achieving a balance between restoring shoulder mobility and facilitating soft tissue recovery. Shoulder arm pouch sling for 6 weeks advised post operatively. As soon as the patients became comfortable pendulum and scapula stabilizer exercises started.

No active movements for first 6 weeks. Assisted passive movements were started once 4 weeks elapsed. External rotation as tolerated by patient was advised between 3-6 weeks. At 6 weeks gradual assisted active movements were permitted. Isometric deltoid strengthening exercises initiated at 3 weeks. After 6 weeks rotator cuff strengthening with gradually increasing ROM were focused. Diabetic patients were kept in 30-degree abduction and neutral rotation. Physiotherapy was continuously monitored.

Assessment of cuff integrity

At 1 year follow-up ultrasonography for Sugaya grading and re-tears assessment was done by an experienced musculoskeletal radiologist with a broad-spectrum linear matrix array transducer 14 MHz Midray resona.

Statistical tests

Data were recorded and organized using Microsoft Excel, and later statistical analysis was conducted using analysis of variance (ANOVA), Paired t test and Fischer exact test.

RESULTS

In our study we had total of 26 males and 34 females with 10/60 in age group of 50-59 years, 21/60 were 60-69 years,24/60 were 70-79 years and 5/60 were above 80 years. Cofield classification (small <1 cm, medium 1-3 cm, large 3-5 cm, massive >5 cm).

Comparing arthritis by Hamada classification (1-AHD>6MM,2AHD<5MM,3-2+acetabulisation of acromion, 4-narrowing of gleno-humeral space with/without acetabulisation, 5-4+ humeral head collapse) with functional scoring.

Hamada 1-100% excellent in CMS.86.66% excellent 13.33% good results in UCLA. Hamada 2-76.47% excellent,23.52% good in CMS.53% excellent41.17% good 5.58% fair results in UCLA. Hamada 3-60% excellent,40% good in CMS.60% excellent, 40% fair results in UCLA. Hamada 4 -66.66% excellent, 33.33% good in CMS.50% excellent 50 % good results in UCLA. Fischer exact test used p value<0.05. Total 16 patients of 60 had pre operative fatty atrophy of 2 or above with all showing satisfactory functional outcomes (43.7% excellent, 43.7% good, 12.5% fair by UCLA score.

Clinical outcomes

Table 3 depicts significant improvement in clinical outcomes following cuff repair.

Structural integrity assessment

Sugaya classification is a widely accepted classification system to analyses post-operative rotator cuff tendon integrity. Ultrasonography (US) have recently become cost effective and useful tools for assessing the post-operatively structural properties of the rotator cuff.[4] Out of 60 patients 85% patient reported sugaya grade 1 (70% excellent, 30% good results). 8.33% patient reported sugaya grade 2 (16.66% excellent,33.33% good ,50% had fair results. 3.33% patient had sugaya grade 3 (50% good and 50% fair results). 1.6% patient reported sugaya grade 4 still having a good functional outcome.

Table 1: Functional outcomes.

S. no.	Scores	Pre-operative	Post operative	P value
1	Constant Murley score (0-100)	55.03	94.8	<0.001
2	UCLA score (0-35)	21.58	33.8	<0.001
3	Simple shoulder score (0-12)	6.03	11.2	<0.001

Table 2: Constant Murley score and UCLA score in different sizes of cuff tear.

	CMS				UCLA			
	Small	**Medium**	**Large**	**Massive**	**Small**	**Medium**	**Large**	**Massive**
Excellent	7	37	3	1	7	27	2	1
Good	0	3	9	0	0	13	6	0
Fair	0	0	0	0	0	0	4	0
P value	<0.001				<0.001			

Table 3: Comparison of clinical outcomes pre and post surgery.

S. no.	Parameter	Pre-operative	Post operative	P value
1	Active forward flexion (0-180)	96.50±20.98	166.5±11.62	<0.001
2	External rotation (0-90)	57.83±12.63	79.16±10.13	<0.001
3	Visual analogue scale (0-10)	7.3±1.14	1.2±0.75	<0.001
4	Strength (max 0-25)	10.95±2.56	22.78±3.32	<0.001

Table 4: Comparing different parameters with Sugaya grading.

Parameters	Sugaya 1	Suagaya 2	Suagaya>=3	P value
Vas score (0-10)	1.02±0.62	2.16±0.75	2.33±0.58	<0.001
Constant Murley score (0-100)	97.06±5.21	82.67±9.42	81.33±6.35	<0.001
UCLA (0-35)	34.10±1.66	28.66±3.67	30.67±4.04	<0.001
Muscle strength (0-25)	23.63±2.51	18.5±4.04	17.00±2.00	<0.001

Table 5: Improved score following biceps tenotomy.

Parameter	Pre-op score	Post op score	P value
Active forward flexion (0-180)	97.86±24.24	165.00±14.01	0.001
Vas score (0-10)	7.07±1.33	1.00±0.88	0.001

DISCUSSION

All 60 single row arthroscopic rotator cuff repair (ARCR) showed significant increase in constant score 55.03 to 94.8 (p<0.001), UCLA 21.58 to 33.8 (p<0.001), and simple shoulder score 6.03 to 11.2 (p<0.001), as well as increase in active forward flexion from 98.16 to 166.5 (p<0.001), external rotation form 57.83 to 79.16 (p<0.001), strength from 10.95 to 22.78 (p<0.001), and decrease VAS from 7.2 to 1.2 (p<0.001), shows satisfactory clinical and functional outcomes. Single row repair reduces number of anchors used and directly reduces cost of operation.

Huang in his systematic meta-analysis review compared mini open vs ARCR concluding that both have similar clinical outcomes.[5] ARCR has lower incidence of fibrous ankylosis and increased forward flexion.[6] Josh stated that sutures passing through cuff has major role in functional outcomes rather than number of anchors used.[7] Mazzocca in his cadaveric investigation found no distinction between single-row fixation and double-row fixation in terms of displacement with cyclic loading and load to failure. Both repair groups failed at greater than 250N.[8]

Nicholas in RCT with level 2 evidence demonstrated excellent outcomes for both SR and DR repair.[9] Faulkner in his meta-analysis showcased that type 2 failures close to Musculo tendinous junction occur more frequent in DR than SR and also showed that a SR repair with triple-loaded anchors is more resistant to gap formation than DR constructs.[10] Millet studied single-row vs double-row fixation and noted no difference in functional scores.[11] These studies highlights that double row repair has no significant advantage and increases the cost and burden on patients in developing countries

Subscapularis repair

The deltoid and supraspinatus muscles functions as the coronal force couple while subscapularis and infraspinatus muscles serve as axial force couple. Rotator cuff muscle compresses the humeral head to the glenoid during shoulder abduction and provide joint stability. Protection against excessive external rotation is provided by the subscapularis. Subscapularis tears are also commonly present in patients who undergo ARCR.[12] Barth et reported 40% of arthroscopically diagnosed tears had normal examination which highlights the role of arthroscopy.[13]

Repair of the subscapularis can facilitate posterosuperior cuff repair and decrease tension on adjacent supraspinatus repairs.[14] Our study had 21 subscapularis tears along with supraspinatus and infraspinatus tear. Increase in constant score to 94.83 from 55.52 (p value<0.001) with 39.31 mean increase. Cigolotti reported mean increase in Constant score of 32.7 points, Lafosse had 26.6 increase and Toussaint had 25.8 increase. In our study 4.47/10 internal rotation score according to CMS increased to 8.95/10 indicating excellent results.[15-17]

Long head of biceps tenotomy

Full-thickness cuff tears are commonly associated with lesions of the long head of biceps (LHB) which is considered a constant pain producer contributing to anterior shoulder pain and dysfunction which needs a surgical intervention.[18-20] Biceps pulley is either damaged or disrupted in many cases resulting in subluxation LHB. Surgical repair of the anterior portion of the supraspinatus or subscapularis doesn't permit smooth gliding movement of the biceps in the groove.[21] Arthroscopic biceps tenotomy is an easy and fast procedure with less overall operating time and simpler post-operative rehabilitation compared with tenodesis.[22]

The decision for biceps surgery with RCR should be an individualized one based on assessment of each individual patient's biceps lesion.[23] Osbahr reported no significant difference on the cosmetic appearance of tenotomy versus tenodesis.[24] In our study 14 patients were treated with biceps tenotomy who had pain, inflammation subluxated biceps tendon and Rug sign positive. VAS scored significantly decreased in those patients from 7.01 to 1, and Active forward flexion significantly increased from 97.85 to 165 with no popeye sign reported.

Fatty atrophy

Fatty degeneration is assessed according to goutillier staging 16 patients had fatty atrophy grade 2 or above in our study with mean CMS increase from 45.54 to 88 (p<0.001) and UCLA score increase from 14 to 29 (p<0.001) post operatively, which is also depicted by Osti that fatty atrophy isn't a contra-indication for cuff repair.[25] Good functional results obtained by repairing the cuff in grade 3 and 4 fatty infiltration by Burkhart.[26,27]

Tear size

7 patients had small tear, 40 medium tear 13 large to massive tears. Many surgeons prefer Reverse Shoulder Replacement in large or massive tear. Our study treated all those with Single row repair and showed improved functional score and restored structural cuff integrity.[28]

Gleno-humeral arthritis

Gleno-humeral arthritis increased as acromio-humeral-distance (AHD) decreased. ARCR allows restoration of AHD which was 5.92 mm+/- 1.29 mm and increased to 8.8 mm+/-1.79 mm post operatively (p value<0.001) suggesting lower rates of arthritis. Our study shows significant improvement in UCLA scores with 1 year follow-up in Hamada grade 1,2,3,4 with more satisfactory outcomes in lesser grade of hamada (p value <0.05). It denotes that rotator cuff needs to be repaired to slower the progression of gleno-humeral arthritis. Similar outcomes shown by Herve that less arthritis occurs when rotator cuff remains intact.[29]

Medialised repair

Optimal surgical management of RCR is bone to tendon repair which isn't possible in retracted chronic tears with higher grade fatty atrophy. Anatomic repair attempted in those increases the tension leading to retear. After mobilisation of tendon if not possible to perform tension free repair, then anatomic footprint is medialised by creating new site for attachment with <8 mm medialization which doesn't decrease moment arm in abduction. Goutallier highlighted the role of tension free repair to achieve good clinical and functional outcome.[30,31]

Our study with 9 patients having done medialised repair of not more than 8 mm showed increase in CMS from 59.1 to 91.6 (p value <0.05) and UCLA from 19.9 to 32.1 (p value <0.05).

Ultrasonography

Structural reintegration of cuff at 1 year was assessed by Sugaya grading. 85 % patient recorded Sugaya grade 1 ,10 % Sugaya grade 2, 5% Sugaya grade 3 or above in post operative USG. As we advanced in Sugaya grading functional scores decreased. This finding may indicate cases without residual tendinopathy, to present a more satisfactory outcome. In our study functional scores, muscle strength decreased and VAS increased as we moved from Sugaya 1 to 2 to 3 or more.[32,33]

Sugaya's classification indicated significant correlation with the muscle strength score shown by Yoshida in his 62-patient study with full thickness tear.[34] Galatz et al showed recurrent defects, after single-row ARCR, in approximately 94% of repairs. Our mid-term analysis showed just 1/60 patient having retear in ARCR. Russel performed a meta-analysis to demonstrate that patients with intact repairs have significantly greater strength in forward flexion and external rotation than those with re-tears.[35]

Strengths

All cases were full thickness tears operated by single senior author arthroscopically with Single row repair. Data collection and evaluation done by third person. Complete functional and clinical scores analysis done along with ultrasonography to co-relate radiological and functional outcomes in good number of patients. No other study compares parameters like subscapularis repair, LHB tenotomy, fatty atrophy, arthritis and medialised repair with functional and structural outcomes.

Weakness

Its retrospective study with selection of those patient staying in vicinity who managed to visit the hospital for regular follow-up. Functional and radiological assessment done at end of 12 months and not periodically. Neither radiologist nor orthopaedic surgeons were blinded during study.

CONCLUSION

Single row arthroscopic rotator cuff repair offers excellent outcomes cost effectively by reducing number of anchors and with supervised physiotherapy and rehabilitation protocols. Good structural integration of rotator cuff ensures better functional outcomes. Repair of Subscapularis to balance force couple, biceps tenotomy to decrease pain and medialised repair to decrease tension of repaired cuff improves functional scores. Restoration of acromio-humeral-distance decreases progression of gleno-humeral arthritis.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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