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Anterolateral approach for mini-open degenerative rotator cuff repair by transosseous sutures in elderly

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Abstract
Aims and Objectives: This study was undertaken to introduce anterolateral approach for mini-open degenerative rotator cuff tear in elderly and evaluate its outcome and effectiveness.
Material and Methods: This study evaluated 25 cases that were repaired by mini-open repair using anterolateral approach. There were 15 men and 10 women with average age of 57.4 years. Average follow up was 12.6 months. There were 2 partial thickness, 4 small, 8 medium, 8 large, and 3 massive tears. An incision around 5-6 cm from anterolateral edge of acromion and dissected to the raphe between anterior and middle deltoid. Subacromial decompression was done by removing anteroinferior part of acromion. The torn tendon was repaired through single or double row technique using bony tunnels drilled in greater tuberosity. The deltoid was sutured back to remaining acromion. Clinical outcomes were evaluated using the American Shoulder and Elbow surgeon (ASES) scoring system.
Results: The average visual analogue scale (VAS) and ASES scores improved respectively from 8.88, 83.32 preoperatively to 1.04 and 17.68 postoperatively. There were no statistically significant difference between final ASES scores and age, symptom duration. Men had higher final ASES scores than women (p= 0.012)

Keywords: Anterolateral, acromioplasty, transosseous, tear, elderly

Introduction
Rotator cuff tears can lead to variety of clinical manifestations including debilitating shoulder dysfunction and impairment. With advances in shoulder arthroscopy, repair technique for rotator cuff tear have evolved from open techniques to arthroscopically assisted miniopen techniques and then to an all arthroscopic techniques [1-4]. Recently arthroscopic rotator cuff repair has been popular and satisfactory outcomes are reported by many authors [1, 5-7]. Its potential advantages include less operative pain, an extremely low deltoid morbidity and faster rehabilitation. Despite these advantages, this procedure is technically demanding and requires great deal of practice for a surgeon to obtain proficiency [8]. Also the initial investment in gazette and the expenditure on various fixation systems makes it very costly and out of reach of common man. Because of this, many surgeons still consider the mini-open technique to be the gold standard [3, 6]. Satisfactory clinical outcomes for mini-open technique have been well documented and compared favorably with those for open and arthroscopic techniques [7-17].
Mini-open repair with a lateral deltoid splitting approach is commonly used and generally produces good long term results comparable to those seen in open repair series [10, 15, 18]. However attempts to repair large or massive tears can lead to significant deltoid and axillary nerve injury from excessive traction. Assessment of medially retracted tendons and visualization of subscapularis is difficult.
Anterior approach provides good visualization and avoids axillary nerve injury whereas assessment of posterior cuff tear is difficult [19-20]. Matsen and Lippitt [21] described miniopen repair using a deltoid on approach through a 3-4 cm split in most prominent anterior raphe of deltoid muscle near its origin on acromion.
Present study is considering tears in old age (>50 yr.) where bony spur formation at anteroinferior aspect of acromion digging into supraspinatus is common. In an attempt to better assess rotator cuff tear an modified approach which author names as anterolateral

approach which allows acromioplasty and a small deltoid split in raphe allowing access to even massive tear s extending posteriorly as well as anteriorly subscapularis and origin of long head of biceps.

Aims and Objectives

The purpose of this study was to introduce the anterolateral approach for mini-open rotator cuff repair and evaluate its clinical outcome and effectiveness.

To study effectiveness of repair of cuff by multiple pull out sutures through greater tuberosity

Material and Methods

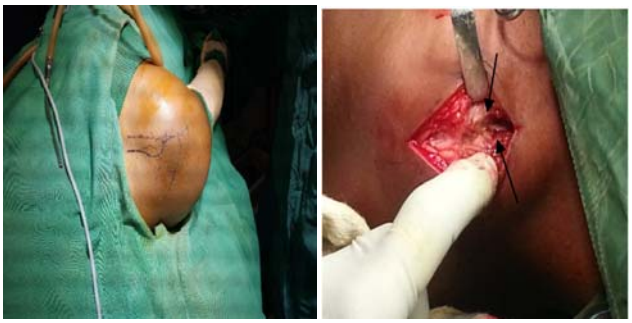
Between January 2013 to December 2015, 34 consecutive patients older than 50 yr. age with rotator cuff tear underwent mini-open repair by a single surgeon using anterolateral approach. Of those patients 25 followed up for over one year were evaluated. Institutional ethical committee approval was taken and informed consent was obtained. Average patient age was 56.56 (50-65) years. There were 15 men and 10 women, among which 17 (68%) were dominant and 8 (32%) were nondominant limb. Average duration of symptoms before surgery was 11.48 (2- 26) months. Average follow up period was 15.08 (12-24) months. Of 25 patients 13(52%) had preoperative shoulder stiffness. All patients underwent preoperative MRI.

Surgical technique

With patient in supine position with a sandbag under scapula which allows extension of shoulder to expose posterior cuff and given interscalane block, the upper extremity is draped free which allows movements of shoulder to bring different parts of cuff in view intraoperatively.

Manipulation of shoulder was done in patients with preoperative shoulder stiffness.

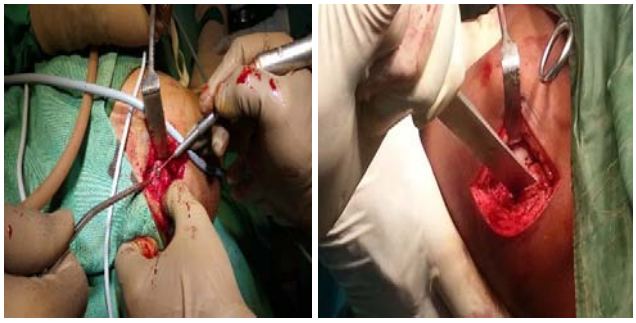
A 4-5 cm incision is taken on anterolateral edge of acromion and extended distally to carry dissection between raphe between anterior and middle part of deltoid. The deltoid is detached with cautery from anterior edge of acromion bring cuff in view. (Fig.1 a, b)



(a) (b)

Fig 1: (a) showing surface marking of the incision and (b) Showing incision from the anterior edge of acromion with the dissection to the raphe between anterior and middle deltoid

Acromioplasty was done either with a sharp osteotome (antero inferior part of acromion was osteotomized and the bon e piece is peeled off from cuff) or with the help of high speed burr (Fig.2a, b)



(a) (b)

Fig 2: Acromioplasty was done with a sharp osteotome (a) or with high speed burr (b)

The torn tendon was tagged by traction sutures after removing the hypertrophic bursal tissue (Fig.3) around the split site to improve visualization, we confirmed involvement and configuration of torn tendon by rotating the arm and attempted anatomical reduction on the footprint of greater tuberosity.

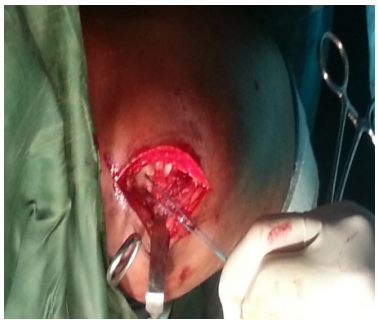


Fig 3: The torn tendon was tagged by traction sutures

Trough is made in the foot print with curette and rasp. 2-4 tunnels are drilled in greater tuberosity through floor of trough exiting laterally and 1-3 horizontal mattress sutures with No 2 nonabsorbable sutures (ETHIBOND) depending on size of tear and knots are tied on lateral surface. (Fig.4) 1-2 deloading sutures are placed through tendon to tie on the threads on lateral surface remaining after knotting.

Fig 4: Fixation of the torn tendon by transosseous sutures

For large trapezoidal and massive tears, the anterior and posterior edges are sutured to each other (Fig.-5) and the remaining edge is attached as described above.

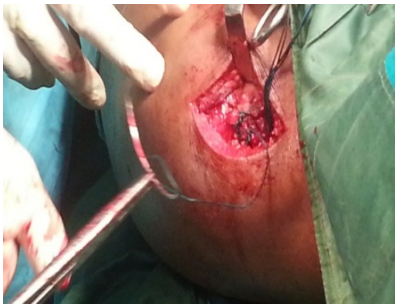


Fig 5: Suturing of anterior and posterior edges for large trapezoidal tears

In cases where bringing the tendon to footprint is not possible, the trough is made just at the margin of articular cartilage. If pathology in biceps tendon is found then tenodesis is performed under direct vision. To prevent avulsion of deltoid from acromion, osteoperiosteal sutures are taken to acromion with no. 1 OS absorbable sutures (Vicryl). (Fig.-6)

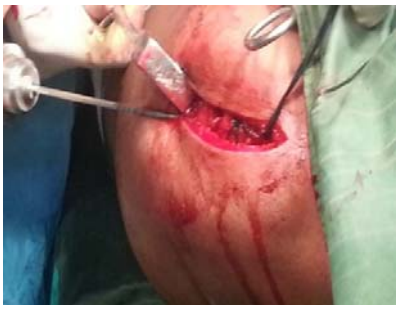


Fig 6: Osteoperiosteal repair of deltoid origin to acromion

Skin sutured with 3-0 nonabsorbable (ethilon) suture. Arm sling pouch was given. Patients began pendulum exercises and passive range of motion exercises one day after surgery. They began active range of motion exercises at three months and occupational and sports activities at six months.

Patients were followed at one and half months, three months, six months and one year.

Clinical assessment

We evaluated preoperative and final follow up visual analogue scale (VAS) for each patients. Clinical outcomes for all patients were evaluated using the American Shoulder and Elbow Surgery (ASES) scoring system. All patients completed the ASES questionnaire preoperatively and at the final follow up. The shoulder index as calculated by ASES scoring system was used to obtain overall results, Excellent >or=90, good 80-89, fair 70-79, poor<70

Statistical analysis

To examine baseline characteristics, we analyzed frequency and descriptive statistics. To determine the correlation between clinical outcome and various parameters as age, sex, affected side, symptom duration, preoperative stiffness, and tear size, we used Kruskal- Wallos test, Chi square test, Wilcoxon Signed Ranks test, Mann-Whitney test, Statistical significance was fixed at $p<0.05$.

Results

Rotator cuff tear size and shape confirmed intraoperatively were analyzed. Two patients were having partial thickness tear. Rest 23 full thickness tear were classified depending on size with Cofield classification. And depending on shape by Ellman and Gartsman classification as follows.

Table 1: Depending on size (Cofield) [22]

Sr. no	Tear description	No of patients	Subdivision depending on shape
1	Small (<1cm)	4	Crescent -4
2	Medium (1-3 cm)	8	Crescent -5 L shape -1 Inverted L-1 Trapezoidal -1
3	Large (3-5cm)	8	L shape -3 Trapezoidal-5
4	Massive (>5cm)	3	Massive -3

Table 2: Depending on shape (Ellman and Gartsman) [23]

Sr. no.	Tear description	No. of patients	Subdivision depending on size
1	Crescent	9	Small-4 Medium-5
2	Reverse L	1	Medium -1
3	L shaped	4	Medium-1 Large-3
4	Trapezoidal	6	Medium -1 Large-5
5	Massive	3	Massive-3

13 patients (52%) underwent manipulation before actual surgical procedure. One patient underwent biceps tenotomy.

Table 3: Statistical correlation between variables and preoperative ASES scores

Variable		Number	Mean of Preop ASES score	P value
Sex	Male	15	79.4+/- 10.225	0.012
	female	10	89.2+/- 8.315	
Affected side	Dominant	17	85.63+/- 8.9111	0.521
	Nondominant	8	82.24+/- 11.228	
Preoperative stiffness	Stiff	13	83.75+/- 8.137	0.957
	Nonstiff	12	82.92+/- 12.593	
Tear size	Partial	2	77+/- 14.142	0.128
	Small	4	73.25+/- 12.58	
	Medium	8	82+/- 7.387	
	Large	8	87.5+/- 8.734	
	Massive	3	93.33+/-7.234	

Analysis of preoperative ASES scores and various parameters showed statistically significant lower preoperative scores in women (p=0.012). There was no statistically significant difference in preoperative scores by age, affected side, symptom duration, stiffness or tear size.

Table 4: Topographic classification in sagittal plane (Haber Mayer) [24]

Type	Number of patients	Mean of Preop ASES score	Mean of final ASES score
A (Anterior)	0	0	0
B (Superior)	23	31	8.83
C (Posterior)	0	0	0
B+C	2	87.86	9.5

Both groups appear to have significant improvement

Table 5: Retraction pattern (Patte) [25]

Type	Number of patients	Mean of Preop ASES score	Mean of final ASES score
I (Close to bony insertion)	3	70.66	4.33
II (humeral head level)	17	91.70	12
III (glenoid level)	5	62.4	21.0

All groups appear to have significant improvement.

Table 6: Type of acromion (Bigliani) [26]

Type	Number of patients	Mean of Preop ASES score	Mean of final ASES score
I (Flat)	1	67	0
II (Curved)	10	79.4	13
III (hooked)	14	87.28	22.28

24 patients of type II & III had irregular osteophytic anteroinferior edge of acromion digging into supraspinatus suggesting degenerative cuff pathologies are more common in these groups.

Average VAS scores improved from 8.88 (range 6-10) preoperatively to 1.04 (range 0-3) at final follow up (p<0.0001). The average ASES scores improved from 83.32 (Range 58-67) to 17.68 (range 0-40) at final follow up (p<0.0001)

Table 7: VAS and ASES scores

	Preoperative	Final	Z score	P value
VAS	8.88+/- 1.092	1.04 +/- 0.889	-4.422	0.000
ASES	83.32+/- 10.479	17.68 +/- 10.621	-4.378	0.000

Table 8: Statistical correlation between variables and final ASES scores

Variable		Number	Mean of final ASES score	P value
Sex	Male	15	13.8+/- 9.66	0.028
	female	10	23.5+/- 9.641	
Affected side	Dominant	17	20+/-11.058	0.448
	Nondominant	8	16.59+/-10.572	
Preoperative stiffness	Stiff	13	17.33+/- 10.084	0.913
	Nonstiff	12	18+/- 11.496	
Tear size	Partial	2	2.5+/-3.536	0.012
	Small	4	9+/- 6.164	
	Medium	8	18.5+/- 6.568	
	Large	8	19.88+/- 11.407	
	Massive	3	31.33+/- 1.155	

There was no statistically significant difference between final and follow up ASES scores and age, affected side, symptom duration, preoperative stiffness. There was significant difference in final ASES scores and tear size (p=0.012) and men showed significantly higher ASES scores than women (p=0.028)

Individual 10 activities of ASES scoring system in pre and final scores were studied. From scores it appears that more affected activities were put on coat, sleep on affected side, washing back or to do up bra, combing hair. More improvement is seen in put on coat and sleep on affected side, while washing back or to do up bra, reaching high shelf, lift overhead, throw a ball are improved to lesser extent indicating lesser improvement in achieving range of motion in terms of abduction, flexion and internal & external rotations. Statistical analysis was done using Wilcoxon Signed Ranks Test

Table 9: Comparison of Individual 10 activities of ASES scoring system in pre and final ASES scores

No	Activity	Preop ASES score	Final ASES score	Z value	P value
1	Put on coat	2.84+/- 0.374	0.52+/-0.586	-40513	0.000
2	Sleep on affected side	3+/-0	0.2+/-0.408	-4.667	0.000
3	Wash back or do up bra	2.84+/-0.374	1.16+/-0.8	-4.463	0.000
4	Toileting	1.36+/- 0.952	0.24+/-0.436	-3.839	0.000
5	Combing hair	2.52+/-0.51	0.88+/-0.666	-4.5	0.000
6	Reach high shelf	2.44+/-0.507	1.04+/-0.539	-4.419	0.000
7	Lift 4.5 kg weight above shoulder	2.52+/-0.51	1.32+/-0.627	-4.388	0.000
8	Throw a ball overhead	2.28+/-0.458	1+/-0.577	-4.463	0.000
9	Usual work	2.08+/-0.572	0.44+/-0.507	-4.54	0.000
10	Usual sport/leisure	1.6+/-0.645	0.48+/-0.653	-4.46	0.000

There is statistically significant decrease in final score in all 10 activities

There were 8(32%) excellent, 8(32%) good, 5(20%) fair, 4(16%) poor results. Postoperative complications include stiff shoulder in 3(12%), Post-operative infection in one (4%) which resolved by dressing and finally after coming out of suture thread. there were no reoperation in followed period.

Discussion

The most important finding of this study was that this technique provided better visualization for rotator cuff tear of all sizes and satisfactory clinical outcome. The interested fact that the roughened anterior edge of acromion along with anteroinferior osteophytes digging into supraspinatus tear with lot of inflammatory bursa was a constant finding in these elderly patients with degenerative tears. So that doing acromioplasty by removing anteroinferior part of acromion either by sharp osteotome or high speed burr not only achieved good subacromial decompression but allowed good exposure of cuff. Further deltoid splitting approach for repair is a well-established excellent technique for treating full thickness tears and offers many advantages of either open or arthroscopic techniques while minimizing disadvantages [17].

Cost is a definite concern in developing countries and especially in public hospital like ours where the economically poorer section of community visits for treatment. Also, availability of a shoulder arthroscopic surgeon is an issue. As present method is not using operative arthroscopy system which takes care of gazette related issues as well as nonavailabilty of expertise issues. The method of fixation used is transosseous sutures and not fancy anchors and fixation systems. This takes care of cost related issues. This is a still commonly used and promising technique that can reduce postoperative pain and deltoid morbidity. Also clinical results are well documented. And compared favorably with those for open or all arthroscopic techniques [10, 11, 14, 17, 18].

Recent studies comparing miniopen repair with all arthroscopic repair show no statistically significant difference between the two techniques [1, 2, 5, 9, 12, 13, 15, 17]. However most studies comparing all arthroscopic repair with miniopen repair in patients with full thickness tears are neither randomized controlled trials nor prospective cohort studies.

The lateral approach involving lateral deltoid splitting has proven satisfactory in long term results however it leads to significant deltoid and axillary nerve injury due to excessive traction during attempts to repair large or massive tears and limits visualization of medially retracted cuff tears and subscapularis tears. The anterior approach provides good visualization and avoids axillary nerve injury but it is difficult

to assess posterior cuff tear [11, 19-20]. Matsen and Lippitt [21] described miniopen repair with deltoid on approach carried out through a 3-4 cm split in the most prominent anterolateral raphe of the deltoid muscle near its origin form the acromion. Several authors reported that during miniopen repair blunt dissection between anterior and lateral raphe of deltoid allows exposure of rotator cuff without deltoid detachment or injury. [15].

Our anterolateral miniopen technique using a modified deltoid –on approach, representing a smaller version of a standard open repair, has several advantages.

- It allows direct access to anterior supraspinatus, which is most common site of rotator cuff tear.
- In smaller tear the cuff will be clearly visible in deltoid spit, in larger tears the arm can be rotated in extension and internally to allow better visualization of posterior aspect of cuff.
- Flexion and external rotation allows excellent visualization of biceps groove and subscapularis.
- It allows for less experienced surgeons to confirm adequacy of subacromial decompression by digital palpation. And to perform biceps tenodesis easily.

Previous literature is controversial regarding the effect of tear size and age and retraction on outcome after rotator cuff repair with some studies reporting that these factors influenced outcome and others opposite [6, 27, 29]. Romeo *et al*. reported that tears more than or equal to 5 cm^2 were associated with poorer outcome. However, Baysal *et al.* [27] prospectively reviewed 84 patients with tears of all sizes, including 17 with large or massive tears, who underwent miniopen repair, and reported a statistically significant improvement in shoulder scores and range of motion. They found no difference in outcome with respect to tear sizes. Subsequent reports demonstrated that miniopen techniques can be used effectively for even large and massive tears [19-20, 28]. In our study patient experienced significant decrease in pain and had significant improvement in pain and ASES scores. Of 25 patients, 21(84%) had satisfactory outcome. It is noteworthy that 7 of 11 patients with large and massive tears had satisfactory outcome. Our data are consistent with those of previous studies that obtained >80% satisfactory results with miniopen technique [3, 17]. Our subgroup analysis showed no statistically significant difference between the final follow up ASES scores and age, affected side, symptom duration, preoperative stiffness. But tear size had influence and men had significantly higher significant ASES scores than women. Our technique provided both adequate exposure for repairs of all sizes and satisfactory clinical outcomes for patients with large to massive tear.

Some studies advocate either transfer latissimus dorsi or reverse shoulder for patients with retraction up to glenoid and fatty infiltration or atrophy of supraspinatus. However in present study all such patients underwent repair using described method and had statistically significant improvement in all groups. Thus author feels that this method is definitely advisable in old patients with degenerative tear and definitely can postpone major surgeries.

All ten activities in ASES score pre and final are studied individually and statistically significant improvement was found in all. More affected activities preoperatively were put on coat, sleep on affected side, wash back or do up bra and combing. More postoperative improvement is seen in put on coat, sleep on affected side and combing while wash back or do up bra, reaching high shelf, lift overhead, throw a ball are improved to a lesser extent indicating indicating lesser improvement in achieving range of motion in terms of flexion abduction and rotations. But all patient s are subjectively satisfied with the end result as pain reduced dramatically.

One disadvantage of miniopen repair is that it can produce stiffness after surgery. Incidence ranging between 11% and 20% have been reported [1, 4, 16]. However Youn *et al*. [30] compared outcomes of all arthroscopic repairs versus miniopen repair and found no evidence of stiffness in patients treated with miniopen technique. Although several studies have shown increased range of motion for the all arthroscopic repair in early postoperative period, Verma *et al*. [2] reported no difference after all arthroscopic versus miniopen repair at two year follow up. In our study one patient (4%) had postoperative stiffness who had a massive tear. The results are similar to those reported for all arthroscopic repair. To prevent avulsion of deltoid from acromion, additional suturing with osteoperiosteal sutures was performed using no 1 OS 8 cutting needle. We believe that this technique is quite useful as none of the patients had deltoid problems.

The limitations of our study is that the number of patients is small and that it did not compare our outcome with cohort that underwent an open or all arthroscopic or partly arthroscopic partly open technique. Furthermore we did not assess the integrity of repaired rotator cuff at follow up evaluations. There is a need for prospective randomized clinical trial with prespecified hypothesis and confirmatory postoperative imaging studies to evaluate outcomes of rotator cuff repair with either miniopen or all arthroscopic technique.

Conclusion

Anterolateral approach for miniopen rotator cuff repair with attachment by pull out sutures produces satisfactory results. It allows visualization of tears of all types.

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