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Does change in occupancy ratio and fatty infiltration of the supraspinatus influence functional outcome after single-row rotator cuff repair? A magnetic resonance imaging–based study

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Introduction: The purpose of this study was to analyze the correlation of occupancy ratio (OR) and fatty infiltration (FI) to functional outcome and retear rate following rotator cuff repair by single-row technique.

Material and methods: Retrospectively, all the patients (n = 100) with rotator cuff tear were evaluated preoperatively and postoperatively with functional scores (American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form [ASES], University of California–Los Angeles [UCLA] shoulder score, Constant score) and magnetic resonance imaging (MRI) for OR and FI. Two observers studied the MRI data separately. Statistical analysis was done using SPSS (version 16), paired *t* test, Pearson correlation, and intraclass correlation coefficients.

Results: The mean (± standard deviation) follow-up was 16.24 ± 6.39 months, and the mean age was 56.18 ± 7.5 years. There was a significant increase in muscle atrophy (decreased OR) and FI ($P < .01$). The mean preoperative and postoperative ORs were 0.57 and 0.51, respectively. However, the mean functional scores improved significantly for ASES (55.78 to 82.09), UCLA (19.44 to 28.47), and Constant score (49.73 to 75.07) ($P < .001$). There was no significant difference in functional outcome among the different stages of FI (ASES $P = .341$, UCLA $P = .839$, Constant $P = .376$). Seven patients had asymptomatic retear during follow-up, of which 2 patients had grade 3, 4 patients had grade 2, and 1 patient had grade 1 FI, preoperatively.

Conclusion: Muscle atrophy and FI are irreversible phenomena and continue even after successful repair; however, they do not have a significant influence on the functional outcome at short-term follow-up after cuff repair. Repairing cuff with higher grades of FI can be performed as they achieve significantly improved functional outcomes.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Occupancy ratio; fatty infiltration; rotator cuff repair

Institutional Review Board approval was received from Ganga Medical Center.

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Rotator cuff tears constitute one of the most common causes of shoulder pain, with overall rates estimated to be around 30% of patients in the United States,[26] whereas magnetic resonance imaging (MRI)–based studies reported 26.2% prevalence in the asymptomatic population and 49.4% in symptomatic patients.[24] The significant correlation between increasing age and rotator cuff tears[31] has been established from previous studies. Full-thickness tears do not heal spontaneously, and the majority (36%-50%) of the cuff tears gradually progress in size,[19,25,32] leading to increased retraction, muscle atrophy, fatty infiltration (FI), and glenohumeral arthritis.[28] The integrity of all the cuff components is imperative to center the humeral head on the glenoid by maintaining coronal and transverse force couples that are essential for optimal functioning of the shoulder (Fig. 1).

The prime objective of all surgical techniques is to achieve adequate tendon to bone healing, thereby providing a good functional outcome. It has been proposed that degeneration of muscle results from the lack of neurogenic feedback, an imbalance in the muscle-tendon stress, or physiologic changes in the muscles themselves resulting from tendon-bone discontinuity.[9] Muscle atrophy and fatty degeneration are the most important prognostic factors in predicting functional outcome and muscle strength after rotator cuff repair.[6,7] Some authors claim that muscle atrophy and fatty degeneration can be halted or reversed[29] after successful cuff repair whereas others have described them as irreversible phenomena[10,11] despite rotator cuff repair. Very few studies[23] have analyzed its correlation with functional outcome, and most of those studies assessed only supraspinatus repairs and included all cuff repairs done using various techniques like mini-open and arthroscopic single- and double-row repairs, which may have confounded the results. In our study, all types of rotator cuff tears repaired by a single technique were analyzed for change in occupancy ratio (OR; estimating muscle atrophy) and FI of the supraspinatus and its implications on functional outcome. The purpose of this study was to analyze the correlation of OR and FI in relation to functional outcome and retear rate following rotator cuff repair by single-row technique.

Materials and methods

This is a retrospective study of all the patients who underwent arthroscopic single-row rotator cuff repair between October 2014 and October 2016 at our institute. Inclusion criteria for this study were patients with full-thickness rotator cuff tear (includes isolated supraspinatus [SS] tear, SS+IS [infraspinatus] tear, SS+IS+SSc [subscapularis] tear, and SS+SSc tear) who underwent complete repair via arthroscopic single-row technique with a minimum of 12 months' follow-up and with 2 sets of MRIs (preoperative and at 12-month follow-up) taken at our institute. Patients with irreparable cuff tears, biceps tendon pathology, labral tears, and glenohumeral arthritis were excluded from the study.

One hundred patients (male 62 and female 38) satisfied our inclusion criteria, and all the patients were preoperatively and postoperatively evaluated with functional scores (American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form score, the Constant score, and University of California–Los Angeles shoulder score) and MRI. MRI evaluation was done using the Hospital Picture Archiving and Communication System (Medsynapse PACS, v.5.0.1.3; Medsynaptic Pvt. Ltd., Pune, India) in our institution to access muscle atrophy and FI in all types of rotator cuff tears. Atrophy of the supraspinatus muscle was measured at the most lateral section of the oblique sagittal image at the point where the scapular spine was still in continuity with the body of the scapula forming a Y shape (Y view) as described by Thomazeau et al.[30] The cross-sectional area of the supraspinatus muscle (A1) and supraspinatus fossa (A2) was measured; then, by dividing A1 by A2 the OR of the supraspinatus muscle was determined. To assess interobserver reliability, a fellowship-trained musculoskeletal radiologist and a fellow in sports medicine measured the MRI-based values at separate intervals. Fatty degeneration was graded as proposed by Goutallier[12] on the sagittal oblique section of MRI preoperatively and during final follow-up, whereas the healing status of the cuff was staged as proposed by Sugaya[27] on MRI obtained at final follow-up (Figs. 2 and 3).

All patients were operated under general anesthesia with a brachial block in beach chair position. Using a standard arthroscopic portal, the shoulder joint was examined. Through a

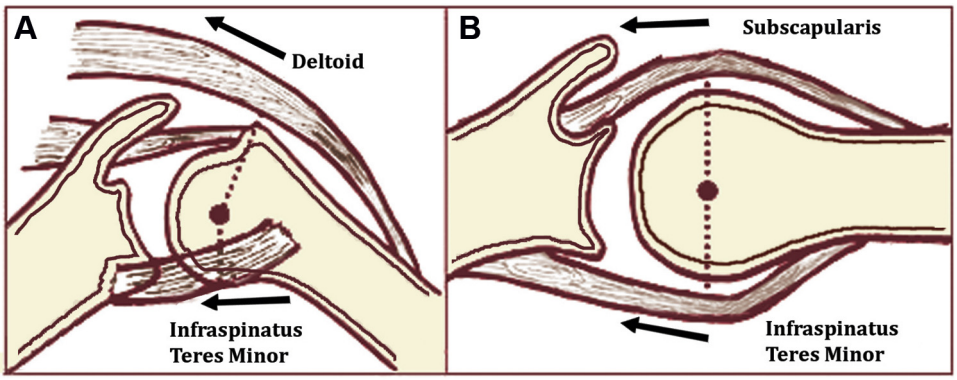


Figure 1 Balanced force couple maintained by rotator cuff muscle for optimal function of the shoulder: (**A**) Coronal force couple deltoid muscle force is balanced by the infraspinatus and teres minor muscle force. (**B**) transverse force couple; subscapular muscle fourse is balanced by the infraspinatus and teres minor muscle force.

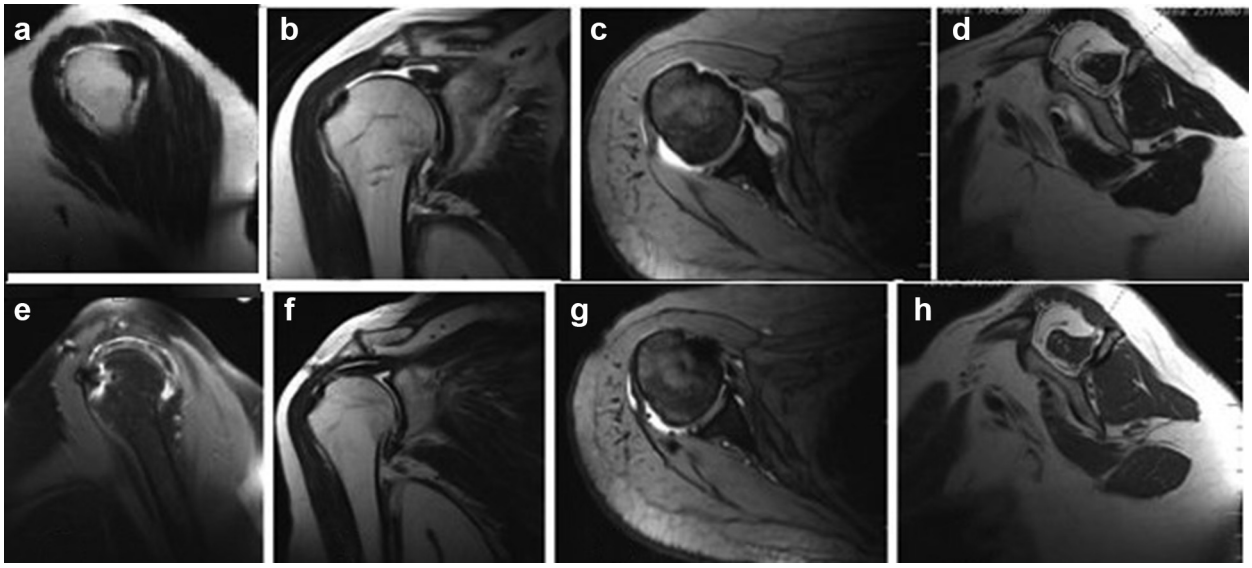


Figure 2 A 62-year-old female patient with an atraumatic chronic rotator cuff tear. (**a**, **b**, **c**) A large-sized supraspinatus and subscapularis tear was noted on the preoperative sagittal, coronal, and axial magnetic resonance imaging (MRI) scan. (**d**) Preoperative Goutallier grade 2 fatty infiltration and occupancy ratio of 0.37 in sagittal Y view. (**e**, **f**, **g**) Final follow-up shows type 1 repair integrity as per Sugaya classification. (**h**) The occupancy ratio diminished from 0.37 preoperatively to 0.33 at the 12-month follow-up; fatty infiltration increased.

working lateral portal, subacromial bursectomy was performed. Torn tendons were mobilized. Single-row cuff repair was performed using double-loaded suture anchors employing a horizontal mattress configuration. In the presence of impingement, an acromioplasty was performed. The same institutional rehabilitation protocol was followed for all patients under the supervision

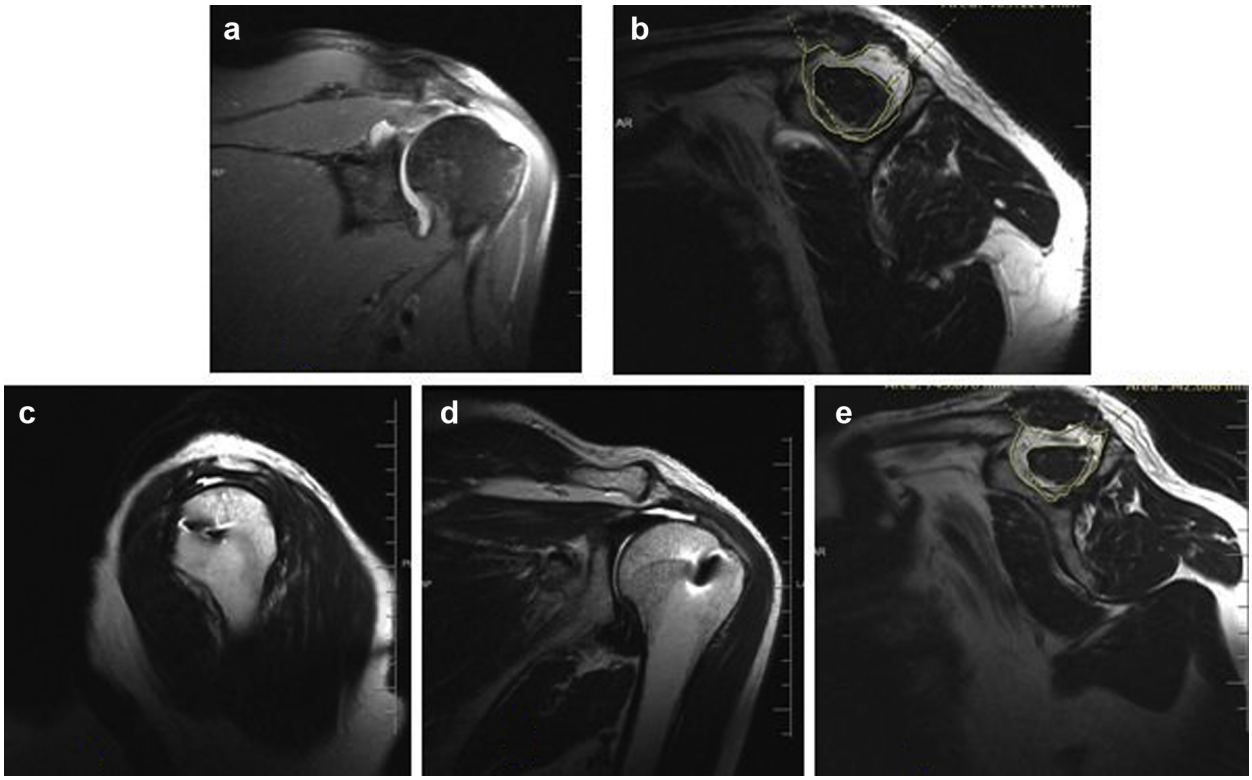


Figure 3 A 58-year-old male patient with an atraumatic chronic rotator cuff tear. (**a**) A large-sized supraspinatus tear was noted on the preoperative, coronal magnetic resonance imaging (MRI) scan. (**b**) Preoperative Goutallier grade 2 fatty infiltration and occupancy ratio of 0.40 in sagittal Y view. (**c**, **d**) Final follow-up showed type 4 repair integrity as per Sugaya classification, that is, retear of the supraspinatus in sagittal and coronal view of MRI. (**e**) The occupancy ratio diminished from 0.40 to 0.35, with increased fatty infiltration from preoperation to 12-month follow-up.

of our senior physiotherapist. The shoulder was immobilized for 3 weeks in an abduction brace, followed by passive and active-assisted forward flexion exercises till near-normal forward flexion was achieved, which usually happened by 8 weeks. Abduction brace was discontinued after 6 weeks. Active forward flexion and abduction exercises were started after 8 weeks. Theraband stretching, rotation, and active strengthening exercises were initiated after 12 weeks. Patients were not allowed to carry heavy weights or drive 2- or 4-wheelers until 16-18 weeks post-operatively. Full shoulder range of movements and overhead activities were obtained by 12 weeks after surgery.

Statistical analysis

Continuous variables including preoperative and postoperative clinical scores (American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, Constant score, and University of California–Los Angeles shoulder scores) were compared using the paired *t* test. Changes in muscle atrophy on MRI were evaluated via the paired *t* test. Correlations between variables were measured by Pearson correlation analysis. The analysis was conducted using SPSS (version 16.0 for windows; IBM, Armonk, NY, USA). Intraclass correlation coefficients between the 2 independent observers were analyzed. The *P* value of $<.05$ was taken as being of significance for all statistical tests.

Results

One hundred patients (male 62 and female 38) with a mean age of 56.18 ± 7.5 years (range, 42-74 years) were followed with a mean follow-up of 16.24 ± 6.39 months (range, 12-35 months) (Table I). There was a significant improvement of Constant, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, and University of California–Los Angeles shoulder scores at final follow-up (*P* value $<.001$; Table I) irrespective of the type of tear (Fig. 4).

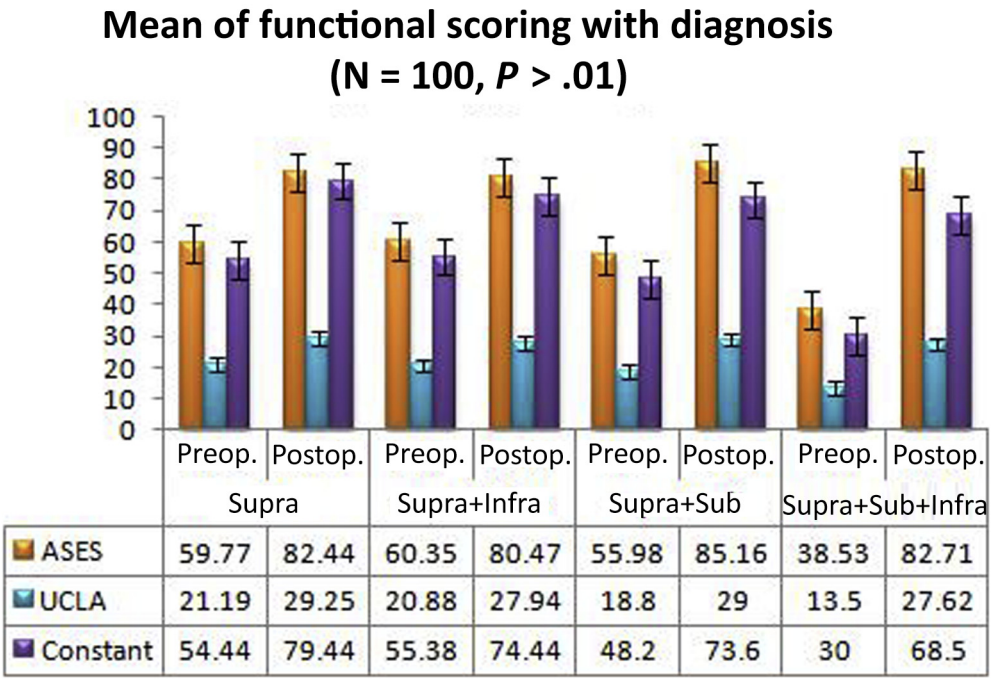
Significant increase in muscle atrophy (ie, decreased OR) was seen after successful rotator cuff repair (Fig. 5). The mean preoperative OR was 0.57 and 0.53, and the mean postoperative OR was 0.51 and 0.48 as measured by observer 1 and observer 2, respectively (Table II). The mean decrease in OR was 0.06 and 0.05 as measured by observer 1 and observer 2, respectively, and this decrease in OR was statistically significant ($P = .001$ and $P = .004$; Table II). The interclass correlation coefficient, that is, the agreement between the 2 observers, was 0.827. The mean preoperative OR was highest in patients in the supraspinatus and subscapularis tears group and least in patients in the supraspinatus, infraspinatus, and subscapularis tears group (Fig. 5). There was a positive correlation between preoperative OR and both preoperative and postoperative functional scores (Table III), suggesting that patients with lower preoperative muscle atrophy will have good functional scores. Age of the patient and retraction of cuff had a weak and significant negative correlation with OR, suggesting that patients of older age and greater retraction of the cuff will have higher muscle atrophy (Table III). Duration of symptoms before surgery also showed a weak negative correlation with preoperative and postoperative OR (correlation coefficients = 0.2 and 0.3, $P = .2$ and .09, respectively). Patients who had higher preoperative OR (good muscle mass) had better healing as per Sugaya staging (Table IV). OR had a negative correlation with Sugaya stage of healing. Seven patients had asymptomatic retears (Sugaya stage 4) and the mean preoperative OR in this group was 0.45, whereas the mean preoperative OR in patients with healed cuff tears was 0.57. However, this difference was not statistically significant ($P = .16$).

Preoperatively, the number of patients in different grades of FI were as follows: 9 in grade 0, 40 in grade 1, 34 in grade 2, 17 in grade 3, and no patient in grade 4, whereas

Table I Patient demographics (N = 100)

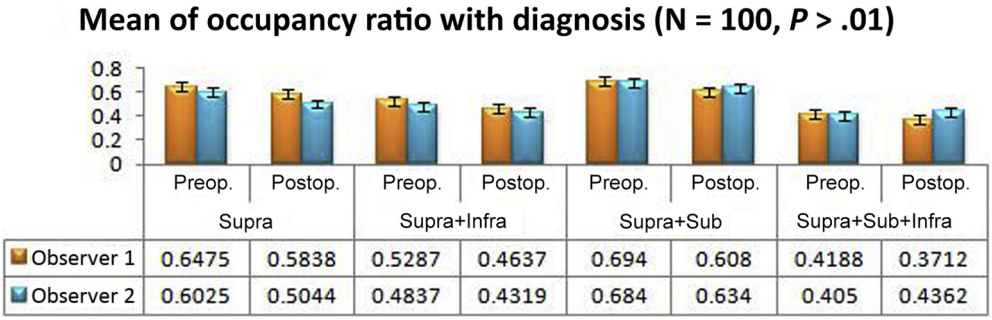
Variable	Value
Age, yr, mean ± SD (range)	56.18 ± 7.52 (42-74)
Sex, male/female, n	62/38
Involved side, right/left, n	56/44
Duration of symptoms, mo, mean ± SD (range)	4.41 ± 4.30 (1-24)
Duration of follow-up, mo, mean ± SD (range)	16.24 ± 6.39 (12-35)
Type of tear (diagnosis), n	
SS tear	36
SS+IS tear	38
SS+IS+SSc tear	16
SS+SSc tear	10
Retraction, cm, mean ± SD	
SS tear	0.97 ± 0.79
SS+IS tear	2.02 ± 1.04
SS+IS+SSc tear	2.43 ± 1.40
SS+SSc tear	1.48 ± 0.48
Functional score preoperation and at final follow-up, mean ± SD ($P < .0001$)	
ASES score	
Preoperative	55.78 ± 23.64
	82.09 ± 11.72
UCLA score	
Preoperative	19.4 ± 8.92
	28.4 ± 4.2
Constant score	
Preoperative	49.73 ± 22.11
	75.07 ± 13.09
Repair integrity at final follow-up (Sugaya staging),n	
Type 1	73
Type 2	20
Type 4	07

SD, standard deviation; *SS*, supraspinatus tear; *IS*, infraspinatus tear; *SSc*, subscapularis tear; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *UCLA*, University of California–Los Angeles shoulder score.



	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
	Supra		Supra+Infra		Supra+Sub		Supra+Sub+Infra	
ASES	59.77	82.44	60.35	80.47	55.98	85.16	38.53	82.71
UCLA	21.19	29.25	20.88	27.94	18.8	29	13.5	27.62
Constant	54.44	79.44	55.38	74.44	48.2	73.6	30	68.5

Figure 4 Mean functional scores (ASES score, the Constant score, and UCLA score) in all 4 types of rotator cuff tear groups. *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *UCLA*, University of California–Los Angeles shoulder score; *Preop.*, preoperative; *Postop.*, postoperative; *Supra*, supraspinatus; *Infra*, infraspinatus; *Sub*, subscapularis.



	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
	Supra		Supra+Infra		Supra+Sub		Supra+Sub+Infra	
Observer 1	0.6475	0.5838	0.5287	0.4637	0.694	0.608	0.4188	0.3712
Observer 2	0.6025	0.5044	0.4837	0.4319	0.684	0.634	0.405	0.4362

Figure 5 Mean occupancy ratio in a different type of tear and intraclass correlation coefficients between the 2 independent observers. *Preop.*, preoperative; *Postop.*, postoperative; *Supra*, supraspinatus; *Infra*, infraspinatus; *Sub*, subscapularis.

during final follow-up, 3 patients were in grade 0, 36 in grade 1, 32 in grade 2, 24 in grade 3, and 5 in grade 4, which clearly show that there was an increase in the number of patients with higher FI postoperatively, and it was statistically significant. Concerning OR and FI, the mean postoperative OR showed a gradually decreasing trend (atrophy of supraspinatus) in patients with higher grades of preoperative FI; however, it was not statistically significant ($P = .09$) (Table V and Fig. 6).

There was a significant increase in FI ($P < .01$). Patients with a lesser degree of FI had better functional scores at follow-up (Fig. 7). Age of the patient had a weak but significant positive correlation ($r = 0.35$, $P = .019$), with preoperative FI suggesting that as age increased, the FI also increased. Duration of symptoms before surgery and retraction of cuff also showed a weak positive correlation with preoperative FI, which was not statistically significant (correlation coefficient = 0.19 and 0.27; $P = .2$ and .06, respectively). In our study, 93% of repairs healed (stage 1 and 2 Sugaya healing) at final follow-up. In 17 patients who had grade 3 FI, 2 patients developed retear at follow-up but the remaining patients demonstrated good healing. Among the retear group, 4 patients had grade 2 FI and 1 patient had grade 1 FI preoperatively. Duration of symptoms and tendon retraction had a weak positive correlation with FI and was not significant (correlation coefficient = 0.092, $P = .54$). Retraction in different groups of patients was different, with the highest seen in patients having supraspinatus, infraspinatus, and subscapularis tears (mean = 2.4 cm) and the lowest in patients with isolated

Table II Preoperative and postoperative occupancy ratio and intraclass correlation coefficients between the 2 independent observers' analysis

	Number of patients	Mean (SD)	Error mean	*P* value
Observer 1				<.001
Preoperative OR	100	0.5698 (0.15753)	0.02348	
Postoperative OR	100	0.506 (0.16362)	0.02439	
Observer 2				.004
Preoperative OR	100	0.5342 (0.1656)	0.02469	
Postoperative OR	100	0.4809 (0.16661)	0.02484	

Table III Correlation of occupancy ratio with other factors that could possibly have an implication over all results

Variable	Pearson correlation (*r*)	*P* value
Age of patient, yr	−0.395	.007
Duration of symptoms, mo	−0.188	.222
Retraction of tendon, cm	−0.516	.001
Repair integrity at final follow-up (Sugaya staging)	−0.265	.078
Fatty infiltration	−0.638	.005
Functional score		
ASES score		
Preoperation	0.185	.223
Postoperation	0.176	.247
UCLA score		
Preoperation	0.188	.215
Postoperation	0.089	.561
Constant score		
Preoperation	0.323	.03
Postoperation	0.244	.106

ASES, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *UCLA*, University of California–Los Angeles shoulder score.

supraspinatus tears (mean = 0.9 cm). This difference among groups was significant ($P = .005$).

Discussion

ORs and FIs are the prognostic factors that are identified in follow-up MRI, and from this study it is seen that decrease in OR with an increase in FI is inevitable even after a successful repair. However, this change in the early postoperative period does not affect the functional outcome of the patient and needs correlation at long-term follow-up with advancing age of the patient. Nonoperated retracted rotator cuff leads to cuff-tear arthropathy and is more commonly seen than realized.[4] Neer et al[22] attributed this phenomenon to inactivity, disuse, synovial fluid leakage, and humeral head migration. Early surgical intervention can avert advanced stages like muscle atrophy, FI, and glenohumeral arthropathy, which have poor outcomes. Further, atrophy and fatty degeneration progress during the nonoperative treatment of rotator cuff tears,[21] and theoretically, repair of the rotator cuff should halt or reverse atrophy of the supraspinatus muscle; nevertheless, till date it has been controversial.

Table IV Mean preoperative occupancy ratio of supraspinatus muscle mass and its effect on postoperative rotator cuff healing (Sugaya stage of healing) after successful repair

Number of patients	Mean occupancy ratio	Sugaya staging	Significance (*P* value)
73	0.59	1	.161
20	0.49	2	
7	0.45	4 (retear)	

Table V Mean postoperative occupancy ratio in patients with different grades of fatty infiltration

Fatty infiltration (Goutallier grade)	Number of patients	Mean occupancy ratio	Significance ($P < .05$)
0	9	0.5844	
1	40	0.5277	.09
2	34	0.4267	
3	17	0.412	

From our study, it is evident that a significant decrease in the mean OR did not halt or reverse after cuff repair. On the contrary, studies by Deniz et al[3] and Liem et al[17] compared the preoperative and postoperative occupation ratios and found no change in muscle atrophy, whereas Gladstone et al[10] reported that muscle atrophy continued regardless of the presence of retear. Thomazeau et al[29] reported a reversal of supraspinatus atrophy in one-half of the successfully repaired rotator cuffs, with no cases of failed repair, in 30 patients from preoperative MRI and follow-up MRI. Similarly, Hamano et al[13] and Chung et al[2] had also reported improvement of muscle atrophy postoperatively. Contrary to our findings, YongPark et al[34] studied 47 patients and reported no significant difference in the area of the supraspinatus muscle between the preoperative time point and at 6-month follow-up. There was a slight (11.3%-13.9%) increase in muscle volume at the final 2-year follow-up, as seen on serial MRI. In contrast, in Chung et al, 81 of the 191 patients (42.4%) showed improvement of atrophy, and in Hamano et al, postoperative muscle atrophy improved in patients with partial-tear and small to medium-size rotator cuff tears, and the large- to massive-tear group did show reversal of muscle atrophy. Further, in

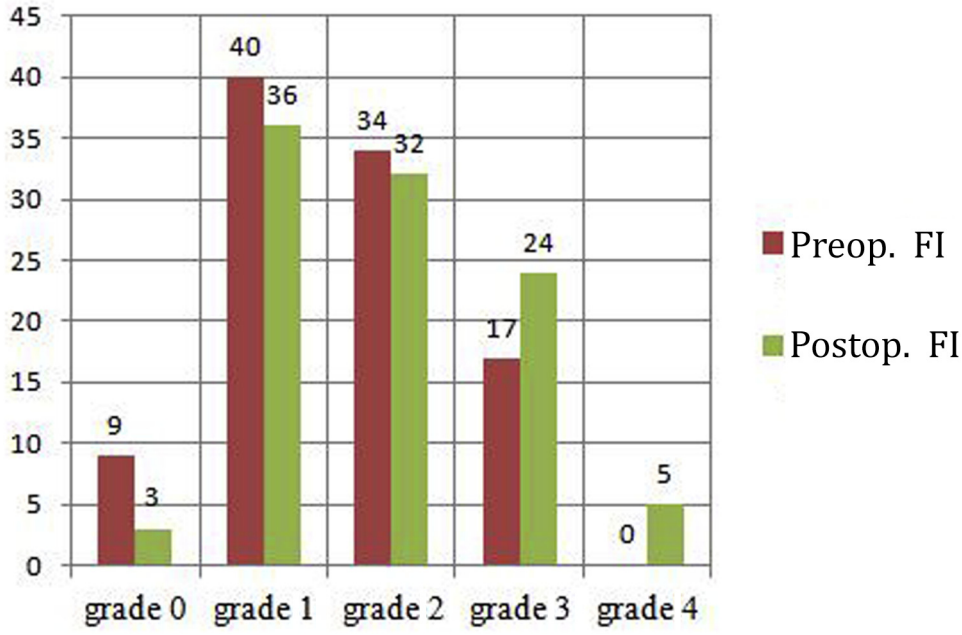


Figure 6 Comparison of preoperative and postoperative fatty infiltration (FI) after rotator cuff repair, with the number of patients shown for each grade of FI. *Preop.*, preoperative; *Postop.*, postoperative.

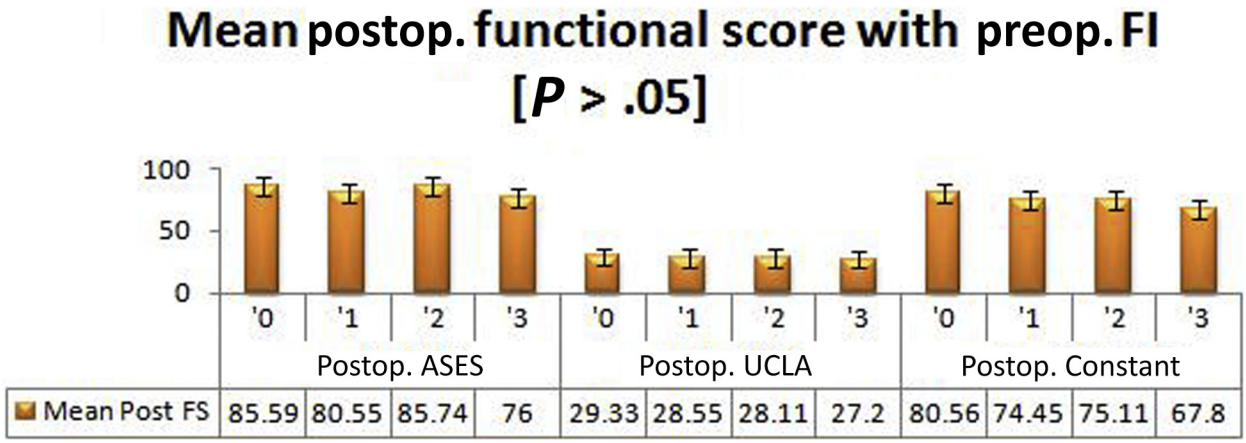


Figure 7 Implication of preoperative FI on functional outcome, where the Y-axis depicts postoperative scores and the X-axis shows grades of preoperative FI: grades 0, 1, 2, 3. *Postop.*, postoperative; *Preop.*, preoperative; *FI*, fatty infiltration; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *UCLA*, University of California–Los Angeles shoulder score; *FS*, functional scoring.

his study, MRI taken shortly after the repair was taken as a reference, whereas in our case preoperative MRI was taken as a reference for comparison. Despite nonreversal of muscle atrophy or OR, we had good clinical and functional outcome and a positive correlation with preoperative OR similar to Shen et al,[23] who found preoperative OR of the supraspinatus muscle to be a good predictor of functional outcome. In their study, all patients had isolated supraspinatus tears, whereas we included patients with infraspinatus and subscapularis tears, which could have influenced the OR. Concerning factors (age, duration of symptoms, and retracting of tear) and OR, we found that older patients, patients with longer duration of symptoms, and patients with more retraction had more muscle atrophy, which differs from those of Nakagaki et al,[20] who found no correlation between the period of preoperative symptoms and the degree of supraspinatus atrophy.

Yamaguchi et al,[33] Hamano et al,[13] and Goutallier et al[11,12] reported that FI within the cuff muscles improved after the repair, whereas Deniz et al[3] and Liem et al[17] reported that there was no change between the preoperative and postoperative findings. The results of our study indicated an increase in postoperative FI that was comparable to the findings of Lee et al[16] and Gladstone et al.[10] In a

study by YongPark et al,[34] there was a slight increase in muscle volume at final follow-up at 2 years, and FI was not reversed ($P = .077$). Gerber et al[8] reported, based on an experiment using sheep, that FI in the cuff muscles never improved because of the morphologic features of the pennate muscle. Goutallier et al reported that the age of the patient did not affect the amount of fatty degeneration; however, Matsen et al[14] reported an increase in fatty degeneration with increasing age. Our study also showed similar findings, with age having a positive correlation with the grade of FI. This finding was consistent with previous studies by Fuchs et al[5] and Nakagaki et al.[20]

In our study, it was quite evident that retear rates were higher in patients with poor supraspinatus muscle mass (lower OR), which was similar to the findings of Thomazeau et al,[29] who reported that supraspinatus muscle atrophy was a strong predictive factor of postoperative retears. Further, in our study 7 patients had retears, and there could be a combination of various factors affecting the eventual results. In those 7 patients, 4 patients had 2 tendon tears (supraspinatus and infraspinatus) preoperatively with a mean retraction of 1.5 cm, and the remaining 3 had tears in all the 3 tendons with a mean retraction preoperatively of 3.5 cm, and the average age among them was 65 years, with 1 grade 1, 4 grade 2, and 2 grade 3 FIs.

Iannotti et al[15] and Mihata et al[18] observed that 95% of the retears were detected up to 6 months after surgery, which was consistent with our finding where we found all the 7 retears were seen at the end of a 1-year follow-up. Concerning FI and retear rates, we had 17 patients with grade 3 FI in whom 9 had tears in all 3 tendons, 3 had an isolated supraspinatus tear, and 5 had supraspinatus and infraspinatus tears and they achieved good functional scores after successful repair. Two of these 17 patients had retears, and this finding was similar that of Burkhart et al,[1] who concluded that arthroscopic rotator cuff repair in patients with grade 3 or 4 fatty degeneration (50%) can provide significant functional improvement. The practice of not repairing rotator cuff tears in stage 3 FI was largely due to the study by Goutallier et al,[12] wherein he had repaired rotator cuff (in more than 60% of the cases) by an open technique, and he followed extensive global release of the supraspinatus muscle (Debeyre procedure) which could be the reason for poorer results in stage 3 FI. In contrast, our patients had undergone anatomic arthroscopic single-row repair of all tendons based on biomechanical principles restoring the force couples and could be the reason for better result even in the face of stage 3 FI.

Our study had several limitations. First, we had 100 patients with short-term follow-up of a mean 16.24 months, which may not be sufficient to comment on the irreversibility of muscle atrophy and FI. Second, systemic factors of patients, such as diabetes mellitus, vascular disease, and smoking, and their influence on healing, the progression of OR, or FI were not analyzed and could have implications in the outcomes of the patients. Finally, the postoperative activity level of the patient was not considered, which may have influenced the outcome and results.

Conclusion

Muscle atrophy and FI are irreversible phenomena and continue even after successful repair of the rotator cuff. However, it does not significantly influence the functional outcome at short-term follow-up. Repairing cuff with higher grades of FI can be performed as they achieve significantly improved functional outcomes. Understanding the degree of muscle atrophy and FI before surgery can help guide patient expectations. Further, long-term follow-up is needed to better elucidate the implications of OR and FI and results.

Disclaimer

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