

Clinical Outcomes at a Minimum 20 Years Following Arthroscopic Repair of Massive Rotator Cuff Tears

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Background: Massive rotator cuff tears (MRCTs) are technically challenging rotator cuff tears to repair and have a high risk of recurrence. Although favorable short- and mid-term outcomes have been reported after arthroscopic repair, very long-term outcomes remain poorly defined, with available 20-year data derived primarily from open repair cohorts.

Hypothesis: We hypothesized that, similar to extended long-term outcomes after open rotator cuff repair, arthroscopic repair would provide durable improvement in pain and patient-reported function at minimum 20-year follow-up compared to preoperative and mid-term follow-up evaluations.

Methods: A retrospective case series of patients who underwent primary arthroscopic repair of massive rotator cuff tears by a single surgeon between 1998 and 2005. Massive tears involved ≥ 2 tendons or measured ≥ 5 cm, confirmed intraoperatively. Patients with revision, open, or irreparable tears, or incomplete follow-up data were excluded. ASES score, Subjective Shoulder Value (SSV), Simple Shoulder Test (SST), VAS pain, range of motion, and reoperation rates were assessed at mid-term and long-term follow-up.

Results: Of 126 eligible patients, 14 were available for minimum 20-year clinical follow-up (mean age 55.8 ± 8.5 years). Mean follow-up was 92.6 ± 28.0 months (mid-term) and 266.9 ± 28.1 months (long-term). ASES improved from 50.4 ± 19.3 preoperatively to 94.8 ± 6.4 at mid-term and 84.4 ± 12.5 at long-term ($p = .004$), with a significant mid- to long-term decline ($p = .04$). VAS improved from 5.7 ± 2.5 to 0.3 ± 0.9 at mid-term and 1.3 ± 1.9 at long-term ($p < .001$ for both). SSV improved from 42.3 ± 19.4 to 94.0 ± 4.6 at mid-term and 84.2 ± 16.7 at long-term ($p < .001$; mid- to long-term $p = .09$). Mean SST was 76.9 ± 21.8 at long-term. Forward flexion improved from $126.9^\circ \pm 50.2^\circ$ to $164.6^\circ \pm 27.9^\circ$ at long-term ($p = .03$). Twelve patients (86%) returned to sport and no patients required reoperation.

Conclusion: Among patients available for evaluation at a minimum of 20 years, improvements in pain and patient-reported function were maintained compared with preoperative values, although some decline was noted between mid-term and long-term follow-up evaluations. No included patients underwent reoperation.

What this study adds to existing knowledge: Among patients available for minimum 20-year follow-up, improvements in pain and patient-reported function after arthroscopic repair of massive rotator cuff tears remained greater than preoperative levels.

How this study might affect research, practice, or policy: These findings provide preliminary very long-term data that may inform future larger studies evaluating the durability of arthroscopic repair of massive rotator cuff tears.

Study Design: Retrospective Case Series

Level of Evidence: IV

Keywords: Massive rotator cuff tear; Arthroscopic rotator cuff repair; Long-term outcomes; Shoulder arthroscopy; Patient-reported outcomes

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Introduction

Massive rotator cuff tears (MRCTs), defined as tears greater than 5 cm [1], or involving at least two tendons [2], represent a

technically demanding subset of rotator cuff disease [3][4][5]. Disruption of the rotator cable and force couples impairs glenohumeral stability and contributes to weakness, pain, loss of motion, and pseudoparalysis [4][6]. Historically,

tendon retraction, muscle atrophy, and fatty infiltration rendered these tears difficult or irreparable; however, starting in the 1990's advances in arthroscopic visualization, mobilization, margin convergence, and fixation have since expanded the indications for repair in appropriately selected patients [7][8].

For younger, active, nonarthritic patients with mobilizable tears, arthroscopic repair is generally preferred over nonoperative care or reverse shoulder arthroplasty (RSA) as a joint-preserving strategy [4][6][9]. Durability, however, remains the central concern, as massive tears carry elevated retear rates and the potential for late functional decline [6][8]. Importantly, structural and clinical failure are not synonymous, as patients frequently maintain meaningful pain relief and functional improvement despite non-healing [8][10]. Short- and mid-term outcomes after arthroscopic repair have been favorable, but very long-term data remain scarce, and available 20-year evidence has derived primarily from open repair cohorts [10].

The purpose of this study was to evaluate the minimum 20-year clinical outcomes after primary arthroscopic repair of MRCTs, including patient-reported outcomes (PROs), pain, range of motion (ROM), return to sport, and reoperation. We hypothesized that similar to very-long term open rotator cuff repair outcomes, arthroscopic repair would provide durable improvement in pain and patient-reported function at minimum 20-year follow-up compared to preoperative and mid-term follow-up evaluations.

Methods

Study Population

After Institutional Review Board approval (reference no. 2025-1731-EX-v6.7525) was obtained, a retrospective case series was performed of patients who underwent arthroscopic repair of a massive rotator cuff tear (MRCT) by a single surgeon between January 1998 and December 2005. This time point was chosen because it corresponds to the same patient cohort previously evaluated at mid-term follow-up [11], allowing direct comparison of outcomes between mid-term and 20-year follow-up. Inclusion criteria required arthroscopic repair of a MRCT and a minimum of 20 years of follow-up. A massive RCT was defined as ≥ 5 cm in greatest diameter [1] or a complete tear of 2 or more tendons [2]. Exclusion criteria included revision arthroscopic rotator cuff repair (ARCR), open repairs, irreparable tears, and incomplete follow-up data.

Surgical Technique

All rotator cuff repairs were performed arthroscopically with the patient in the lateral decubitus position. The indication for

repair was a symptomatic massive RCT with failure to respond to nonoperative management. All repairs were performed with double-loaded suture anchors (BioCorkscrew FT; Arthrex, Naples, FL). A mean of 4.4 ± 1.7 anchors was used overall, with a mean of 1.6 anchors used to repair a subscapularis tendon tear when present. Repair construct evolved over the study period, with a Double-row (DR) repair performed in 4.0% of cases in years 1 to 3, 34.5% in years 4 to 6, and 58.1% in years 7 and 8, reflecting increasing use of DR fixation as tendon length and mobility allowed a tension-free repair to the bone bed [11]. Mean anchor use differed by construct, with 2.8 ± 1.0 anchors used for Single-row (SR) repairs versus 5.5 ± 1.2 anchors for DR repairs. All knots were tied arthroscopically with a double-diameter knot pusher. A complete repair was defined as complete tendon coverage of the native rotator cuff footprint. A complete repair was achieved in 12 patients (85.7%); the remaining 2 (14.3%) underwent a partial repair. Concomitant procedures included acromioplasty in 14 patients (100%), biceps tenodesis or tenotomy in 7 (50.0%), distal clavicle excision in 5 (35.7%), and coracoplasty in 5 (35.7%). Advanced mobilization techniques were used in 7 patients (50.0%), including an anterior interval slide in 2 (14.3%), an isolated posterior interval slide in 2 (14.3%), and a double interval slide in 3 (21.4%).

Rehabilitation

Postoperatively, patients were immobilized in a sling for 6 weeks. Active elbow flexion and extension were permitted with the arm at the side. At 6 weeks postoperatively, the sling was discontinued, and passive external rotation (ER) and forward flexion (FF) were initiated. At 4 months postoperatively (compared with 3 months for small and medium tears), passive internal rotation (IR), active overhead use, and strengthening were initiated. Full return to all activities, including sports, was permitted at 12 months (compared with 6 months for small and medium tears).

Clinical Assessment and Functional Outcome

Preoperative function was determined by retrospective review of prospectively collected outcomes data obtained before surgery. Preoperative University of California, Los Angeles (UCLA) and American Shoulder and Elbow Surgeons (ASES) scores were calculated from these data. Additional data collected by chart review and review of operative records included basic demographics, preoperative range of motion (ROM) assessed by the operating surgeon, and preoperative pain graded from 0 to 10 on a visual analog scale (VAS), as well as concomitant procedures and complications [11].

Mid-term ROM, like long-term ROM, was self-administered by the patient. This represents a change in measurement

method. Longitudinal ROM should be interpreted accordingly. Mid-term outcomes were previously reported at minimum five years after surgery [11].

Final PROs at minimum 20 years after surgery were assessed using validated, self-administered ROM and ASES questionnaires, as well as the Simple Shoulder Test (SST) and Subjective Shoulder Value (SSV). The ASES is a validated joint-specific outcome instrument; the SST is a validated condition-specific measure; and the SSV provides a patient-derived general shoulder health outcome. A complete UCLA score could not be calculated at final follow-up, as long-term data were collected via patient-completed questionnaires and the UCLA scoring system includes a clinician-assessed strength component. The function domain of the UCLA instrument was reported separately as functional level, a 6-point ordinal scale ranging from 1 (unable to use the limb) to 6 (able to perform normal activities). Additional data collected at final follow-up included VAS pain score, patient satisfaction, return to normal sports or work activity, and any additional surgery.

Statistical Analysis

Statistical analysis was performed on demographic data and outcome measures with paired *t*-tests used when comparing matched preoperative, mid-term, and long-term data within the same patients. Comparisons were performed between

preoperative and mid-term follow-up, preoperative and long-term follow-up, and mid-term and long-term follow-up when available. Summary statistics are presented as mean $\pm$ standard deviation (SD) for normally distributed variables and as median (interquartile range [IQR]) for non-normally distributed variables. Statistical significance was set at $p < .05$ in all cases, and exact *p* values are reported throughout. No formal a priori power analysis was performed given the inherent sample size constraints of a minimum 20-year follow-up cohort. Patients not evaluated at final follow-up were classified as deceased or lost to follow-up by review of the institutional patient database. Baseline demographics (age, sex, WC status, diabetes, smoking), preoperative function (ASES, UCLA, VAS pain, FF), repair technique (SR vs DR), and tear characteristics (tendon involvement, size, and dimensions) were then compared among responders, deceased patients, and patients lost to follow-up using one-way ANOVA and chi-square tests for continuous and categorical variables, respectively. Reoperation status was additionally assessed for the entire original cohort, not only the 14 patients evaluated at long-term follow-up, by review of the institutional patient database for evidence of subsequent ipsilateral shoulder surgery through mid-term follow-up. Statistical analysis was performed using GraphPad Prism (GraphPad Software, San Diego, CA) and Microsoft Excel (Microsoft Corp., Redmond, WA).

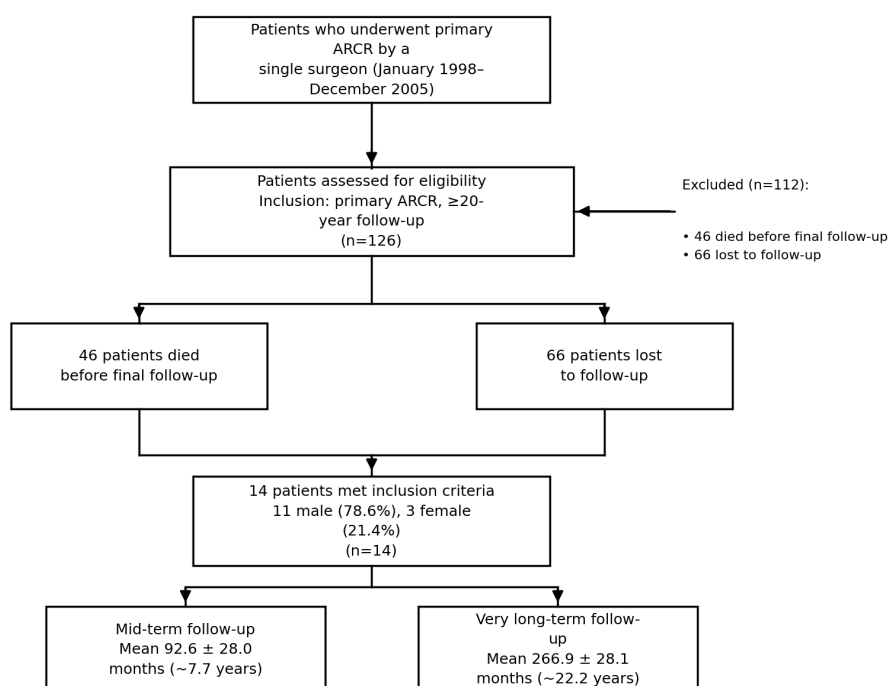


Figure 1: Study flowchart. (ARCR, arthroscopic rotator cuff repair)

Table 1. Demographics

	N (%) or Mean $\pm$ SD
Age at time of surgery	55.8 $\pm$ 8.5
Female gender	3 (21.4%)
Male gender	11 (78.6%)
Workers Comp Injury	4 (28.6%)
Left side	3 (21.4%)
Right side	11 (78.6%)
Dominant shoulder involved	10 (71.4%)
Non-Dominant shoulder involved	4 (28.6%)
Smoker	2 (14.3%)
Diabetic	1 (7.1%)
Tear Characteristics	
Tendons involved, 2	5 (35.7%)
Tendons involved, 3	9 (64.3%)
Supraspinatus tear	14 (100%)
Infraspinatus tear	14 (100%)
Subscapularis tear	9 (64.3%)
Teres minor tear	0 (0%)
Tear size, medial-lateral (cm)	4.1 $\pm$ 2.0
Tear size, anteroposterior (cm)	6.9 $\pm$ 1.2
Subscapularis repaired (when torn)	9/9 (100%)
Biceps tenotomy or tenodesis	7 (50.0%)
Surgery Characteristics	
Number of anchors	4.4 $\pm$ 1.7
SR repair	6 (42.9%)
DR repair	8 (57.1%)
Complete repair	12 (85.7%)
Partial repair	2 (14.3%)
Mid Term Follow-up (mo)	92.6 $\pm$ 28.0
Long Term Follow-up (mo)	266.9 $\pm$ 28.1
Postoperative	
Return to Work	8 (57.1%)*
Return to Sport	12 (85.7%)
Reoperation	0 (0%)

SR: Single-row; DR: Double-row; mo: months; SD: standard deviation; *6 (42.9%) due to retired status

Results

Demographics

Of 126 original patients who underwent arthroscopic repair of a massive rotator cuff tear (MRCT) by the senior surgeon (S.S.B.) between January 1998 and December 2005, 46 had died at final follow-up and 66 were lost to follow-up, leaving 14 patients (11.1%) available for analysis. A total of 14 consecutive patients met final inclusion criteria (**Figure 1**). The mean age at the time of surgery was 55.8 ± 8.5 years. Eleven patients (78.6%) were male and 3 (21.4%) were female. The dominant shoulder was involved in 10 patients (71.4%), with 11 patients (78.6%) undergoing right-sided surgery and 3 (21.4%) undergoing left-sided surgery. Four patients (28.6%) sustained workers' compensation (WC) injuries. Two patients (14.3%) were active smokers, and 1 patient (7.1%) had diabetes mellitus (DM). The mean number of anchors used was 4.4 ± 1.7 . Mean mid-term follow-up was 92.6 ± 28.0 months (approximately 7.7 years), and mean final follow-up was 266.9 ± 28.1 months (approximately 22.2 years). Additional demographic, tear, and surgical characteristics are presented in **Table 1**.

Patient-Reported Outcomes

The mean preoperative ASES score was 50.4 ± 19.3 , improving significantly at both mid-term follow-up (94.8 ± 6.4 ,

$p < .001$) and long-term follow-up (84.4 ± 12.5 , $p = .004$). ASES scores demonstrated a statistically significant decline from mid-term to long-term follow-up ($p = .04$).

The mean preoperative pain VAS score was 5.7 ± 2.5 , improving significantly at both mid-term follow-up (0.3 ± 0.9 , $p < .001$) and long-term follow-up (1.3 ± 1.9 , $p < .001$). There was no statistically significant difference between mid-term and long-term VAS scores ($p = .1$).

The mean preoperative SSV score was 42.3 ± 19.4 , improving significantly at both mid-term follow-up (94.0 ± 4.6 , $p < .001$) and long-term follow-up (84.2 ± 16.7 , $p < .001$). The numerical decline in SSV from mid-term to long-term follow-up did not reach statistical significance ($p = .09$).

The mean preoperative UCLA score was 17.6 ± 4.2 , improving significantly at mid-term follow-up (33.6 ± 1.5 , $p < .001$). Strength improved significantly from 3.4 ± 0.7 preoperatively to 5.0 ± 0.0 at mid-term follow-up ($p < .001$). UCLA score and strength testing were obtained at mid-term follow-up only, as the UCLA instrument requires a clinician-assessed strength component and was not feasible to administer via patient-completed questionnaire at long-term follow-up. At long-term follow-up, the median functional level was 5 (interquartile range [IQR], 3–5) (**Table 2**).

Table 2. Patient-Reported Outcomes and ROM

		Mid Term	Long Term	P Values		
	Preoperative	>5yr Follow Up	>20yr Follow Up	Preoperative to Mid	Preoperative to Long	Mid to Long
ROM						
FF	126.9 ± 50.2	178.1 ± 6.9	164.6 ± 27.9	<0.001	0.03	0.1
ER	43.9 ± 25.0 (n=9)	—	35 (range, -60 to 90) (n=14)	—	0.2	—
IR	2 (range, 2-6) (n=6)	—	5 (range, 2-8) (n=14)	—	0.56	—
Outcomes						
ASES score	50.4 ± 19.3	94.8 ± 6.4	84.4 ± 12.5	<0.001	0.004	0.04
VAS	5.7 ± 2.5	0.3 ± 0.9	1.3 ± 1.9	<0.001	<0.001	0.1
SSV	42.3 ± 19.4	94.0 ± 4.6	84.2 ± 16.7	<0.001	<0.001	0.09
SST	—	—	76.9 ± 21.8	—	—	—
UCLA	17.6 ± 4.2	33.6 ± 1.5	—	<0.001	—	—
Strength	3.4 ± 0.7	5.0 ± 0.0	—	<0.001	—	—
Functional level*	—	—	5 (3-5)	—	—	—

P values in bold; statistically significant. ASES, American Shoulder and Elbow Surgeons; ER, external rotation; FF, forward flexion; IR, internal rotation; ROM, range of motion; SST, simple shoulder test; SSV, subjective shoulder value; VAS, visual analog scale for pain.*Expressed as median (interquartile range); see Appendix Figure 1 for scale. Long-term ER is expressed as median (range) rather than mean $\pm$ SD due to a non-normal, floor-effect distribution (see Results and Supplementary Figure 1). IR is expressed as median (range) because the spinal-level scale is ordinal rather than continuous; preoperative-to-long-term comparison used the Wilcoxon signed-rank test.

Table 3. Comparison of Responders, Deceased, and Lost to Follow-up Patients

Variable	Responders (n=14)	Deceased (n=46)	Lost to F/U (n=66)	P Value
Age (years)	55.5 ± 8.2	69.8 ± 6.8	58.6 ± 8.3	<0.001
Male sex	78.6%	50.0%	69.7%	0.048
Workers' Compensation	28.6%	8.7%	32.8%	0.012
Diabetes	7.7%	11.1%	16.7%	0.57
Smoking	14.3%	20.0%	9.1%	0.26
Repair technique (double-row)	57.1%	30.4%	36.4%	0.19
Preoperative ASES	50.4 ± 19.3	40.6 ± 15.0	40.7 ± 17.3	0.27
Preoperative UCLA	17.1 ± 3.9	14.9 ± 4.1	15.9 ± 5.1	0.35
Preoperative VAS pain	5.7 ± 2.5	6.3 ± 1.9	6.5 ± 2.4	0.50
Preoperative FF (°)	124.6 ± 48.2	127.2 ± 48.7	137.9 ± 48.5	0.44
Subscapularis tear	64.3%	65.2%	72.7%	0.64
Infraspinatus tear	100%	93.3%	93.9%	0.62
Teres minor involvement	0%	2.2%	0%	0.41
Overall tear size (%)	59.4 ± 26.5	63.9 ± 25.1	57.0 ± 25.4	0.51
Tear medial-lateral dimension (cm)	4.1 ± 2.0	4.6 ± 1.1	4.3 ± 1.4	0.32
Tear anteroposterior width (cm)	6.9 ± 1.2	6.2 ± 1.7	6.2 ± 1.2	0.26

ASES, American Shoulder and Elbow Surgeons score; UCLA, University of California, Los Angeles score; VAS, visual analog scale. P values from one-way ANOVA (continuous variables) or chi-square test (categorical variables).

Range of Motion

Preoperative FF was 126.9° ± 50.2°, improving significantly to 178.1° ± 6.9° at mid-term follow-up ($p < .001$). At long-term follow-up, FF was 164.6° ± 27.9°, remaining significantly improved relative to the preoperative baseline ($p = .03$), with no statistically significant decline from mid-term to long-term follow-up ($p = .1$). The late numerical decrease in FF may reflect the natural decline in shoulder function associated with aging and reduced activity levels over time.

Preoperative ER was 43.9° ± 25.0° ($n = 9$). At long-term follow-up, ER had a median of 35° (range, -60° to 90°; $n = 14$), with no significant difference from preoperative values ($p = .2$). ER is reported as median (range) because three patients had a fixed internal-rotation contracture (unable to achieve neutral rotation), producing a non-normal distribution. Individual patient values are presented in **Supplementary Figure 1**.

Preoperative IR was measured at spinal level, median 2 (range, 2 to 6; $n = 6$). At long-term follow-up, IR was median 5 (range, 2 to 8; $n = 14$), with no significant difference from

preoperative values (Wilcoxon signed-rank test, $p = .56$). IR is reported as median (range) because the spinal-level scale is ordinal, with unequal intervals between landmarks. All ROM data are summarized in **Table 2**.

Return to Activity and Complications

Eight patients (57.1%) returned to work; the remaining 6 (42.9%) were already retired. Twelve patients (85.7%) returned to sport. No patients among the 14 evaluated at long-term follow-up required reoperation. Among the 112 patients not evaluated at long-term follow-up, 1 (0.9%) had a documented ipsilateral reoperation.

Single-Row vs. Double-Row Repair

Long-term outcomes are reported descriptively by construct (SR, $n = 6$; DR, $n = 8$); given the small subgroup sizes, no inferential statistics were performed. ASES was 87.3 ± 7.5 (SR) and 79.4 ± 20.7 (DR). SST was 85.0 ± 10.9 (SR) and 71.9 ± 25.9 (DR). SSV was 0.8 ± 0.2 (SR) and 0.8 ± 0.3 (DR). Forward flexion was 151.7° ± 36.6° (SR) and 176.2° ± 10.6° (DR).

Attrition Analysis

Baseline characteristics were compared among responders ($n = 14$), patients who died before final follow-up ($n = 46$), and patients lost to follow-up ($n = 66$) (Table 3). Patients who died were older at surgery (69.8 ± 6.8 years) than responders (55.5 ± 8.2 years) and patients lost to follow-up (58.6 ± 8.3 years; $p < .001$), consistent with expected mortality over 20 years. Sex and WC status also differed significantly among groups ($p = .048$ and $p = .012$). Preoperative ASES, UCLA, and VAS pain scores, FF, and tear characteristics did not differ among groups (all $p > .05$), suggesting responders were not a healthier subset of the original cohort at baseline.

Discussion

The principal finding of this study is that patients undergoing arthroscopic repair of a MRCT can retain substantial pain relief and function more than two decades postoperatively, despite some decline over time. No patient among the 14 available for long-term evaluation required reoperation. Baseline characteristics did not differ significantly between these responders and the 46 patients who died or the 66 lost to follow-up (Table 3), indicating responders were not a systematically healthier subset. However, 88.9% of the original cohort was not evaluated at final follow-up; these results are therefore representative of patients who remained available for evaluation, not the original cohort as a whole.

Findings from the present study parallel those reported in another study that evaluated minimum 20-year outcomes after open repair of MRCT [10]. In that series, 53 of an original 127 patients were available for assessment; the Constant-Murley score improved from 44.5 ± 15.3 preoperatively to 68 ± 17.7 postoperatively, and 55% of shoulders were rated subjectively excellent or good. The reported final mean SSV of $73\% \pm 23\%$ was similar to, though slightly lower than, the SSV of 84.2 ± 16.7 observed in the present arthroscopic study. Reoperation was more common after open repair, with 10.2% of patients undergoing further surgery and 2.4% converting to reverse shoulder arthroplasty, compared with no reoperations in the present study. The two studies differ substantially in follow-up completeness (53 of 127 patients [41.7%] vs. 14 of 126 patients [11.1%]) and patient selection, which limits direct comparison between reoperation rates. Notably, only 53% of open repairs remained structurally intact at 20 years, and tendon integrity was the strongest predictor of clinical outcome, underscoring that durable clinical benefit can be achieved with either an open or arthroscopic approach even when structural failure is common.

Although MRCTs have historically been considered a difficult pathologic entity, repair has been shown to substantially improve pain, motion, and function, with intact repairs conferring superior strength and PROs compared with return

repairs [2]. Significant improvements across multiple outcome domains have been similarly demonstrated in large and massive chronic tear cohorts, most reliably in mobilizable, repairable tears [12]. Prior arthroscopic series at 8 to 10 years have consistently reported significant improvements in ASES, VAS pain, and FF after MRCT repair, with better outcomes associated with complete repair and DR fixation [11]. The mid-term values of the present study closely parallel these reports, with a follow-up interval that extends beyond prior arthroscopic MRCT series [13][14]. The mid-term advantage of DR fixation was not apparent in the descriptive long-term outcomes of this cohort; given the small subgroup sizes, this should not be interpreted as evidence against a construct effect.

Significant ASES improvement was maintained at 22 years ($p = .004$), consistent with prior long-term studies demonstrating that meaningful clinical improvement can persist despite high retear prevalence. Durable improvements in Constant-Murley scores and SSV have been reported at both 10 and 20 years after massive tear repair despite retear rates of 34% to 52%, supporting the concept that structural failure does not necessarily equate to clinical failure [10][15][16][17][18]. Indeed, clinical scores have been shown to remain excellent regardless of repair integrity on imaging, with tendon integrity most important for maximizing objective strength rather than patient-reported function [18]. The absence of long-term imaging in this cohort precludes direct confirmation of retear rates; however, this distinction between structural and clinical failure is particularly relevant when the surgical goals are durable pain relief, force-couple restoration, and arthroplasty avoidance rather than permanent anatomic normalization.

Late numerical decline in self-reported motion at 22 years likely reflects some contribution from the natural effects of aging over a mean interval of more than two decades rather than progressive repair failure. FF, while numerically lower at long-term than mid-term follow-up, remained significantly above the preoperative baseline ($164.6^\circ \pm 27.9^\circ$ vs. $126.9^\circ \pm 50.2^\circ$, $p = .03$), with no statistically significant mid-term to long-term change ($p = .1$), and pain relief and patient-reported function remained significantly improved at final follow-up. Declining objective parameters at 7 to 10 years after massive cuff repair have been attributed at least in part to aging rather than repair failure [19]. Retained force-couple mechanics rather than structural integrity may underlie this preservation of patient-reported outcomes despite declining motion [20][21], a finding supported by long-term series reporting late decline in ASES scores without loss of durable pain relief beyond 15 years [22]. These findings suggest that long-term functional satisfaction may remain relatively preserved even as self-reported motion gradually declines with age, though

prospective data in larger cohorts are needed to confirm this pattern.

In younger patients, avoiding or delaying RSA may be a meaningful goal given implant longevity concerns, activity expectations, and the complexity of revision surgery. None of the 14 patients who completed long-term clinical follow-up reported reoperation, revision surgery, or conversion to arthroplasty.

Limitations

The major strengths of this study are its minimum 20-year follow-up and the availability of preoperative, mid-term, and long-term data in the same cohort, allowing direct longitudinal comparison. Baseline comparison of responders with nonresponders (Table 3) provided some assessment of attrition bias uncommon in studies of this duration. The major limitation is the retrospective, single-surgeon design, which carries inherent selection bias and a lower level of evidence than a prospective study. Attrition over this 20-year interval was substantial: of the original 126 patients, 46 (36.5%) died and 66 (52.4%) were lost to follow-up, leaving 14 (11.1%) evaluable. Baseline characteristics did not differ significantly among the three groups (Table 3), suggesting responders were not a healthier subset. However, mortality status among the 66 lost to follow-up could not be independently verified, and later reoperation in this group cannot be excluded. These results should be interpreted as applicable to patients who remained alive and available for evaluation at final follow-up, not the original cohort as a whole. In addition, the absence of long-term imaging precludes correlation of clinical outcomes with tendon integrity or glenohumeral arthrosis [23]. Fatty infiltration/Goutallier grade, muscle atrophy, pseudoparalysis, and glenohumeral arthritis were not systematically recorded and could not be reported, limiting characterization of appropriate patient selection. Another consideration is the change in ROM measurement method between preoperative and follow-up assessment; emphasis should therefore be given to the long-term PROs rather than ROM. Finally, no *a priori* power analysis was performed, and findings of no difference are potentially the result of type II error.

Conclusions

In appropriately selected patients, arthroscopic repair of massive rotator cuff tears may sustain clinically meaningful pain relief and functional improvement for more than two decades. These findings are consistent with its potential role as a durable joint-preserving option in patients with massive rotator cuff tears who are candidates for repair, though larger prospective studies are needed to confirm the generalizability of these outcomes.

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Ethical Approval

This study was approved by the Institutional Review Board (reference no. 2025-1731-EX-v6.7525). Informed consent was obtained from all participants prior to completion of the long-term follow-up survey.

Conflict of Interest Statement

Reyhan Meetheen, Eliza Beall, Hunter Czajkowski, and Amanda Strickland: These authors, their immediate family, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

Patrick J. Denard, Stephen S. Burkhart, and Robert U. Hartzler: These authors, their immediate family, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article. For complete disclosure information, please refer to the American Academy of Orthopaedic Surgeons (AAOS) disclosure database.

Equity, Diversity, and Inclusion Statement

All eligible patients meeting predefined inclusion criteria were included regardless of demographic characteristics; however, the study population may not reflect the broader population with massive rotator cuff tears.

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