RESEARCH ARTICLE

Clinical and Radiological Outcomes of Rotator Cuff Repairs Using All-Suture Anchors as Medial Row Anchors

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Abstract

Background: The aim of our study is to report the clinical and radiological outcomes of a series of prospectively enrolled patients who have had double-row transosseous equivalent rotator cuff repairs, where all-suture anchors were used as medial-row anchors, with a minimum follow-up of 1 year.

Methods: Twenty-two consecutive patients underwent arthroscopic transosseous equivalent double-row rotator cuff repair using all-suture anchors as medial-row anchors. Oxford Shoulder Score, Constant Score and Visual Analogue Scale pain score, together with shoulder range of motion, were used preoperatively and at 3 months, 6 months and final follow-up. Radiological evaluation was performed with magnetic resonance imaging at one-year post surgery to assess the structural integrity of the repair and the rate of cyst formation in greater tuberosity.

Results: The patient mean age was 61 years (range 46-75). Minimum follow-up was 1 year, and the mean final follow-up was 15 months (range 12-24). Healing failure in our patients was less than 5% (1/22 patients). There were significant improvements in shoulder function outcome scores at final follow-up. The Constant and Oxford scores were 78 and 44 at final follow-up respectively. There were similar magnitudes of improvement in range of motion (combined abduction and rotation), pain score and supraspinatus strength at final follow up. The improvements in outcome scores were already statistically significant at 3 months ($P<.001$). Using Kim's classification for cyst formation on T2-weighted MRI images, we observed no fluid or minimal fluid collection in 85% of the patients (17/22 patients). There were no correlations between the grade of bone changes and the clinical outcomes.

Conclusion: It is safe to use all-suture anchors as medial-row anchors when performing double-row anchor transosseous equivalent rotator cuff repairs. The purported advantages of all-suture anchors may outweigh their perceived disadvantages in rotator cuff repair surgery.

Level of evidence: IV

Keywords: All-suture anchors, Clinical outcome, Healing rates, Rotator cuff repair

Introduction

Rotator cuff tears are common, may effect in excess of 50% of those over 60 years old and when symptomatic, can result in significant pain and functional loss (1). Rotator cuff repair, the surgical strategy in those with symptoms, is associated with good clinical outcomes and pain relief (1). However, healing rates may be compromised, particularly in the more elderly population (1). Although good clinical outcomes are reported in those with re-tears, those with healed tendons appear to achieve better outcomes, range of motion and strength (1). As a result, there has been a continued drive to find solutions that could enhance

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healing. These have included the enormous advances in technique and implant design as well as instrumentation technology (admittedly some without established clinical evidence (2). The advances in technique have involved a journey from single-row to double-row repair and to some more modern techniques involving patch augmentation with biological or synthetic grafts (3,4).

Similarly, there have been tremendous advances in anchor technology with the aim of developing an ideal anchor design which would lead to a rotator cuff repair construct that allows maximum surface contact area between the greater tuberosity and the repaired tendon, high initial fixation strength without excessive tension on the repaired tendon and minimum gap formation (4). This has involved a journey begining with metal anchors, progressing into absorbable, polyetheretherketone (PEEK), bio-composite anchors and, more recently, all-suture soft anchors (ASA) (5). The latest addition, all-suture anchors, were initally marketed for labral repair, but are now gaining popularity for rotator cuff repair and other procedures (6,7,8,9).

The smaller size and drill holes for these anchors theoretically may offer various advantages, including: bone preservation, greater surface areas of contact between the tendon and bone, reduced risk of anchor complications should they become loose, easier revision surgery and availability of space for complex rotator cuff repairs (including those with additional subscapularis tears and long head of biceps lesions), where more anchors are required to be inserted. Although these possible positive factors are attractive, it is important to ensure there is no compromise of the biomechanical and the biological properties of the reconstruct unit, such that the clinical outcomes and healing rates are not affected. There are theoretical concerns that these anchors have inferior biomechanical properties, such as the reduced pull-out strength and increased risk of micromotion, as well as gap and cyst formation (10).

The aim of our study is to report the clinical and radiological outcomes of a series of prospectively enrolled patients who have had double-row trans osseous equivalent rotator cuff repairs, where all-suture anchors were used as medial-row anchors, with a minimum follow-up of 1 year. Radiological evaluation was performed with MRI at 1-year post surgery to assess the structural integrity of the repair and the rate of cyst formation in the greater tuberosity. Our hypothesis is that good clinical outcomes and healing rates could be achieved when using all-suture anchors and medial row anchors in a double row transosseous equivalent technique.

Materials and Methods

Between October 2017 and February 2019, twenty-two consecutive patients who underwent rotator cuff repairs were prospectively enrolled into this single centre, single surgeon study. In all patients, all-suture anchors were used as medial-row anchors. All were symptomatic complaining of shoulder pain, reduced strength and range of motion.

Preoperative Assessment

Preoperatively, shoulder plain radiographs (antero-posterior and axillary views) and an MRI scan (3T system) were performed in all patients to assess glenohumeral joint status, humeral head position (Hamada classification, RC tear size, retraction and muscular belly fatty infiltration (Fuchs classification) (11, 12). All MRIs were reported by a specialist musculoskeletal consultant radiologist and reviewed by a consultant orthopaedic surgeon to determine if the patients met the inclusion criteria for the study [Table 1]. Patients with severe glenohumeral joint degenerative changes (osteoarthritis grade 4) or severe cuff tear arthropathy (Hamada grade ≥ 4) were excluded from the study.

Tears were classified as per Cofield classification into small (less than 1 cm), medium (1 - 3cm), large (3 - 5cm) and partial thickness tear [Table 2] (13).

All surgeries were primary procedures, as patients who had undergone a previous rotator cuff repair on the same affected shoulder were excluded. Following clinical and radiographic assessment and appropriate counselling regarding the risks and benefits of the procedure, arthroscopic RC repair using all-suture anchors was offered to the patients.

Table 1. Study eligibility criteria

Inclusion Criteria	Exclusion Criteria
Symptomatic, MRI proven partial thickness RC tears	Irreparable RC tears
Full thickness RC tears	OA of the GHJ
Muscular atrophy - Fuchs[20,39] stage I – III	Cuff Arthropathy (Hamada[12] ≥ 3)
	Muscular atrophy – Fuchs [13]stage IV
Age 18 years old or above	History of septic arthritis in affected joint
Full passive range of motion of the affected shoulder	Ipsilateral shoulder instability
Willingness to undergo standardized postoperative rehabilitation	Difficulty in communication due to cognitive impairment or language barriers
Capacity to provide informed consent	Previous rotator cuff surgery

Table 2. Preoperative tear sizes in the 22 patients

Preoperative tear size (Cofield classification)	Number of patients
Partial Thickness (>50%)	2 (9.1%)
Small (<1cm)	3 (13.6%)
Medium (1-3cm)	13 (59.11%)
Large (3-5cm)	4 (18.2%)

Surgical Technique

All operations were performed with the patient in the lateral decubitus position under general anaesthesia and interscalene block. Antibiotic prophylaxis was given following the local institutional guidelines at induction (teicoplanin 400mg and gentamicin 120mg). A standard arthroscopic diagnostic assessment of the GHJ and cuff was performed through a standard posterior port. The size and shape of the tear, tendon quality and the amount of retraction of the cuff tendon were assessed. Arthroscopic subacromial decompression was performed in all patients and acromioclavicular joint (ACJ) excision was performed in symptomatic patients with degenerative ACJ changes visible on plain radiograph.

All rotator cuff repairs were performed by the senior author. A double-row transosseous equivalent technique was employed in all cases using one or two 2.3mm all-suture anchors (Iconix 2.3, Stryker, Kalamazoo, MI)), double or triple loaded, as the medial-row anchor(s) and two standard anchors for the lateral-row (Swivelock 5.5 Biocomposite, Arthrex, Naples, FL). The tendon was first mobilized and then the greater tuberosity footprint prepared with multiple 1.4mm drill holes in order to initiate bone marrow stimulation. Greater tuberosity decortication was avoided in order to not compromise biomechanical properties of the construct. The medial-row anchor/anchors were then inserted according to the manufacturer's technique, using a 2.3mm drill rather than an awl to prepare the anchor holes to minimise cortical bone damage. The anchor suture limbs were then passed through supraspinatus using a standard suture passer.

Once all of the anchor suture limbs had been passed through the cuff, they were tied together using standard arthroscopic knot tying techniques. A transosseous equivalent suture bridge technique was then performed to insert the lateral-row anchors. This involved passing the medial-row suture ends through the 2 lateral-row anchors that are in turn inserted into the distal part of the greater tuberosity.

In 4 patients, an extracellular porcine matrix (Arthrex Dx Reinforcement Matrix, Arthrex, Naples, FL) was additionally used to augment the repaired construct. The technique for this augmentation is previously described but essentially is a modification of the transosseous equivalent technique involving passing the medial-row suture ends over the laid flat augment and then through the 2 lateral-row anchors that are in turn inserted into the distal part of the greater tuberosity, thereby stabilising the lateral edge of the augment (3). The medial edge was also secured to cuff using the strong free suture.

In addition to the procedure described above, subscapularis tendon repair was performed in 4 patients with a single suture fixation using a double-stranded all-suture anchor (Iconix 2.3, Stryker, Kalamazoo, MI). In those patients where subscapularis was repaired, tenotomy (three) or tenotomy of long head of biceps (LHB) was performed (11). Two additional patients underwent LHB tenodesis and another one had tenotomy where LHB was found to be pathological and symptomatic.

Postoperative Protocol

Our standard rehabilitation protocol was used in all patients. All patients were given information regarding the use of sling, activities of daily living, axillary hygiene, education in movements and functional activities to be avoided. Advice regarding recovery of sensation from plexus nerve block if still active was also provided. Shoulders were immobilized in a shoulder abduction wedge (15 degrees abduction and neutral rotation) for six weeks (medium and large tears) or four weeks (small tears). Pendular exercises (Codman's exercises) and elbow mobilization were started immediately postoperatively. Physiotherapy was organized before discharge. Passive and active ROM was allowed once the sling was removed and RC strengthening started at 10 - 12 weeks.

Outcomes recorded

Patients were followed-up at 3 months (T1), 6 months (T2) and final follow-up of at least 12 months (T3). T0 was defined as the preoperative period. Primary outcome measures included the Oxford Shoulder Score (OSS), Visual Analogue score (VAS) for pain, the Constant-Murley Score (CS) and range of motion (ROM), for which abduction (ABD) was recorded in degrees from the hand by the side and internal (IRC) and external rotation (ERC) recorded as per the CS grade.

Radiological assessment of the tendon healing and bone cyst formation were performed using MRI scan (3T without enhancement) at approximately 12 months post-op.

Statistical analysis

The distribution of variables was assessed through a Shapiro-Wilk test. Analysis of variance (ANOVA) (parametric variables) and Kruskal-Wallis (non-parametric variables) with Bonferroni correction were used to compare preoperative clinical scores with postoperative values at timepoints T1, T2 and T3. Univariate analyses were performed to evaluate the association of baseline demographics (age, sex, smoking status, diabetes, history of trauma), preoperative MRI findings (supraspinatus tear size, presence of subscapularis tear, Goutallier Classification (GC) score) and 1-year MRI findings (peri-anchor fluid and cyst formation as per Kim's and Ro's classifications with changes in clinical scores (OS, CS, VAS and strength) between the preoperative (T0) and final follow-up (T3) values (14,15).

For continuous dependent variables, association was

Table 3. Supraspinatus Fatty Degeneration (Fuch's classification) [12]

Supraspinatus Fatty Degeneration (Fuch's classification)	Number of patients
Grade 0	2
Grade 1	13
Grade 2	6
Grade 3	1

tested through Pearson's coefficient correlation (for continuous independent variables) and Wilcoxon rank-sum test (for categorical independent variables). Predictors of change in clinical scores were identified by including those variables found to be independently significant in the univariate analyses in a subsequent multivariable analysis. Similarly, univariate and multivariable analysis was used to compare patients with minimal (Kim's score ≤2) and considerable peri-anchor fluid (Kim's score ≥3) and patients without (Ro's score ≤1) and with (Ro's score ≥2) peri-anchor cysts at the 1-year MRI against demographic variables and last follow-up clinical scores. For categorical dependent variables, Wilcoxon rank-sum test (for continuous independent variables) and Fisher's exact test (for categorical independent variables) were used. For the univariate analysis, a *P-value* of < .10 was chosen as in previous studies, but only parameters with *P values < .05* were considered statistically significant in the final model. All analysis was performed by STATA statistical software package (Version 12.0, Stata Corp, 2011). Statistical significance was accepted for *P<.05*.

Results

Study population

The patient mean age was 61 (range, 46-75), with 11 males and 11 females. Minimum follow-up was 1 year and the mean final follow-up (T3) was 15 months (range, 12-24). Pre-operative tear sizes and fatty degeneration changes are displayed in tables. [Tables 2 ; 3].

Table 4. Clinical parameter scores for all patients at T0 (preoperative), T1 (3 months), T2 (6 months) and T3 (final follow-up, mean time 15 months, range 12 to 24). Multi-comparison tests were performed with ANOVA or Kruskal-Wallis (KW) test for repeated measures into groups and the Bonferroni correction (B) of p-value was used in pairwise comparison into groups between two consecutive control points. Scores were indicated as mean ± SD

Parameter	T0	T1	T2	T3	*P-value*
OSS (0-48 points)	25.9 ± 6.5	35.7 ± 4.7	41 ± 5.1	44.2 ± 3.9	< 0.001 (KW test) T0 vs T1: < 0.001 (B) T1 vs T2: 0.044 (B) T2 vs T3: 0.372 (B)
CS (0-100 points)	40.3 ± 10.3	59.4 ± 13.6	70.5 ± 9.5	78.4 ± 9.3	< 0.001 (ANOVA test) T0 vs T1: < 0.001 (B) T1 vs T2: 0.029 (B) T2 vs T3: 0.153 (B)
VAS (0-10 points)	6.6 ± 1.3	3.8 ± 2.5	2.2 ± 2	1.2 ± 1.3	< 0.001 (KW test) T0 vs T1: < 0.001 (B) T1 vs T2: 0.09 (B) T2 vs T3: 0.614 (B)
ABD (degrees)	100 ± 18.9	146.4 ± 30.2	155.8 ± 20.6	168.6 ± 6.3	< 0.001 (KW test) T0 vs T1: < 0.001 (B) T1 vs T2: 1 (B) T2 vs T3: 0.284 (B)
ERC (points 0-10)	6.5 ± 1.9	8.8 ± 1.7	9.5 ± 0.8	9.9 ± 0.4	< 0.001 (KW test) T0 vs T1: < 0.001 (B) T1 vs T2: 1 (B) T2 vs T3: 1 (B)
IRC (points 0-10)	3.9 ± 1.5	6.2 ± 1.5	7.5 ± 1.3	7.8 ± 1.6	< 0.001 (KW test) T0 vs T1: < 0.001 (B) T1 vs T2: 0.198 (B) T2 vs T3: 1 (B)
Strength (points 0-25)	6.2 ± 3.8	7.4 ± 3.7	9.3 ± 5.1	10.8 ± 5.1	0.001 (KW test)* T0 vs T1: 1 (B) T1 vs T2: 1 (B) T2 vs T3: 0.625 (B)

*for these parameters Bonferroni test showed a significant difference between T0 and T3 (STR: *p* 0.010). OSS: Oxford Shoulder Score; CS: Constant Score; VAS: Visual Analogue Scale Pain Score; ABD: Abduction; ERC: External Rotation Landmarks based on Constant Score; IRC: Internal Rotation Landmarks based on Constant Score.

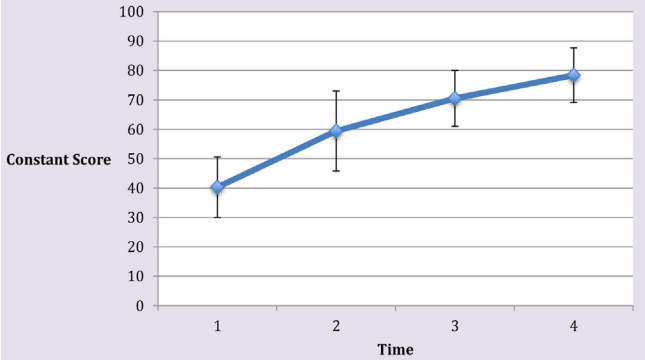

Figure 1A. Line graph showing Constant Scores before surgery (1) and at 3 months (2), 6 months (3) and last follow-up (4).

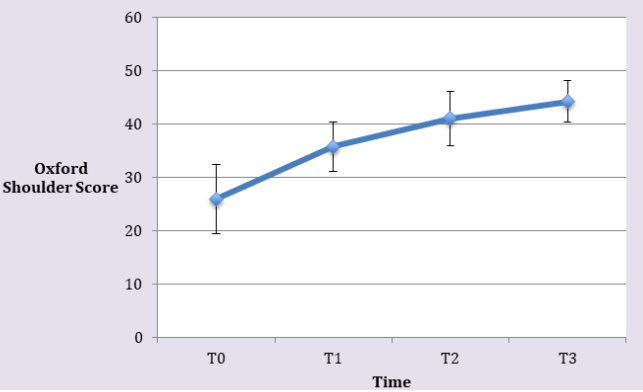

Figure 1B. Line graph showing Oxford score before surgery (1) and at 3 months (2), 6 months (3) and last follow-up (4).

Clinical scores

Preoperative clinical scores (OSS, CS and VAS) and range of motion (abduction ABD, external rotation (according to CS) ERC and internal rotation (according to CS) IRC) significantly improved at 3 months (*P<.05*), with clinical scores further improving between 3 and 6 months (all *P<0.05*) [Table 4] [Figure 1]. OSS improved from 25.9 ± 6.5 to 35.7 ± 4.7 at the 3-month mark (*P<.001*) and 44.2 ± 3.9 at the last follow-up (*P<.001*). CS improved from 40.3 ± 10.3 to 59.4 ± 13.6 (*P<.001*) and 78.4 ± 9.3, respectively at 3-month and last follow-up (*P<.001*).

Regarding the ROM, ABD improved from 100^0 ± 18.90 preoperatively to 146.40 ± 30.20 at 3-month (*P<.001*) and 168.60 ± 6.30 at the last follow-up (*P<.001*). Rotational movements significantly improved at the last follow-up compared to preoperatively (*P<.001*): all patients had full ROM except one who could still reach the top of the head with the hand, keeping the elbow forward (landmark data from the CS); preoperatively, no patient had full ROM and only 45% could reach the top of the head with the hand. The mean ER improvement considering CS landmarks was 3.5 ± 1.9 points (*P<.001*). The mean points gained for IR according to the CS and the level reached by the thumb behind the back was 3.9 ± 2 points (*P<.001*). 36.4% of the patients had no IR movement preoperatively, 41% could only reach the buttock and 22.7% L5 level; postoperatively, 36.4% could reach T12, 40.9% T10 and 22.7% T6 level. The values for each group are reported in Table 4. Patients' supraspinatus muscle strength in ABD according to the CS also significantly improved from 6.2 ± 3.8 points preoperatively to 10.8 points ± 5.1 postoperatively (*P<.001*) [Table 4].

Age was negatively associated with changes in the OSS (*P=0.03*), CS (*P=0.02*) and VAS (*P=0.02*). The presence of a subscapularis tear on preoperative MRI was negatively associated with changes in VAS for pain (*P*=0.09). No other significant correlation was found between other variables (demographics, preoperative and postoperative MRI findings) and changes in clinical scores at univariate analysis. The multivariable analysis revealed that age (*R*= -0.13; *P=0.01*) and the presence of tears of subscapularis (*R*= -2.08; *P=0.03*) were independent negative predictors of change in VAS

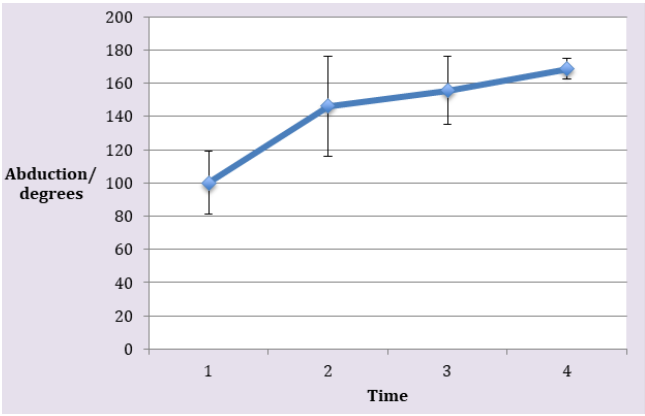

Figure 1C. Line graph showing abduction before surgery (1) and at 3 months (2), 6 months (3) and last follow-up (4).

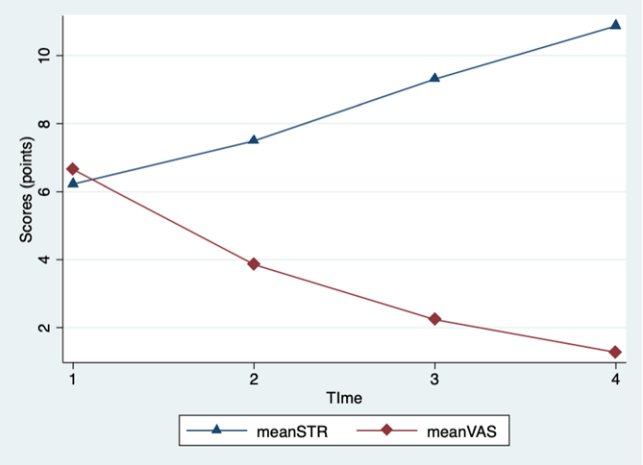

Figure 1D. Line graph showing the differences in strength (triangles) and VAS (diamonds) before surgery (1) and at 3 months (2), 6 months (3) and last follow-up (4).

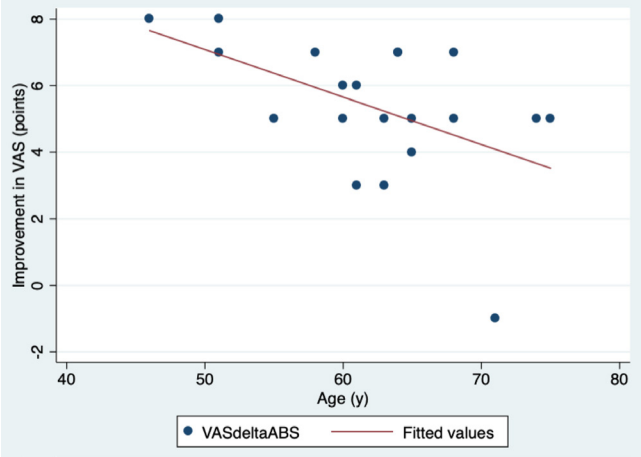

Figure 2. Scatter diagram illustrating the negative correlation between the improvement in VAS at last follow-up (y axis) and the age (x axis) (R= -0.13; *P=0.01*).

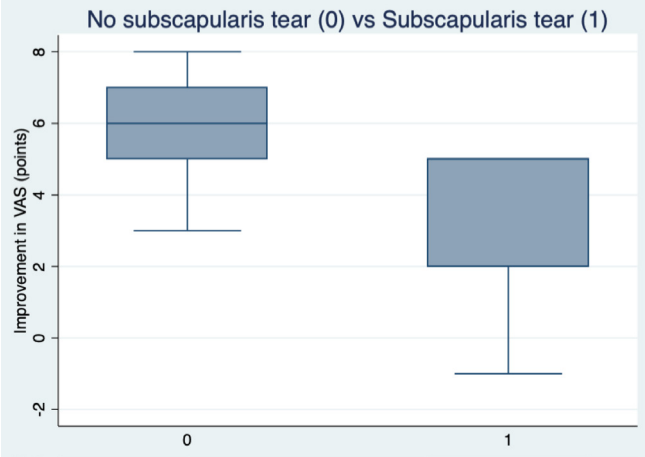

Figure 3. Box and whisker plot showing the difference in improvement of pain (VAS, y axis) in patients presenting without (0) or with (1) a subscapularis tear associated to the supraspinatus (P=0.03). The boxes span the interquartile range, the median is marked by a horizontal line inside it and the ends of the boxes represent the upper and lower quartiles. The whiskers extend to the highest and lowest observations.

[Figure 2; 3].

Healing and peri-anchor bone reaction

To assess the healing status, 20 patients had an MRI and 2 an ultrasound scan (MRI was contraindicated, or patient could not tolerate it). Complete healing was demonstrated in all but one patient at 15-month mean follow-up. According to Kim's classification, in 3 cases (15%) there was no fluid collection (stage 0), in 14 cases (70%) a minimal fluid collection (grade I) and in 3 (15%) a fluid collection around the whole length of the anchor but of a diameter less than twice the anchor diameter (grade III) (15). Demographics (age, sex, smoking status, diabetes, history of trauma) and clinical scores (OS, CS, VAS and strength) did not differ significantly between patient without (Ro's score ≤1) and with (Ro's score ≥2) peri-anchor cysts and between patients with minimal (Kim's score ≤2) and considerable peri-anchor fluid (Kim's score ≥3) (all *P>.05*).

Discussion

Healing failure in our patients was less than 5% (1 out of the 22 patients). This compares favourably with the reported rotator cuff healing rates with all-suture anchors. We report 100% follow-up at minimum 12 months with no complications, as yet to the best of our knowledge.

In a study involving 213 patients with a 10 month follow up, the re-tear rate with all-suture anchor was 29.9%. It is however important to mention that their rate was also reasonably high with bioabsorbable-type standards anchor (33.3%) and PEEK type anchor (22.5%) (16). Their higher re-tears compared to our study may be due to the fact that 17.4 and 12.2% of their patients has massive and large tears respectively compared to 0% and 18.2% in this study. Furthermore, a single repair was performed in their study as compared the double-row repair in our study. In a second study published by the same group in 2019, which consisted of repair for only small and medium tears using all-suture anchors, the re-tear rate (Sugaya grade V) was reported to be only 2.3% (17). Our re-tear rate is similar to that reported by Van der Bracht et al where the re-tear rate was 5% as assessed by MRI in a series of 20 patients undergoing rotator cuff repair with all-suture anchors (17). The difference between our study and their study is that although their technique was double-row, both medial and lateral-rows were "knotted" all-suture anchors whereas we performed a standard transosseous equivalent double-row technique using all-suture anchors as our medial-row anchor and standard classical lateral-row anchor. Transosseous equivalent double-row repair is arguably the most common technique used for medium and large rotator cuff tears (18). In the only other studies involving the all-suture anchors in a transosseous equivalent construct, a bio composite standard anchor was used in addition to all-suture anchor as medial row anchors, so medial row was a combination of the two different type anchors (19). Although clinical outcomes were not reported in their study, the re-tear rate in those patients with a combination of all-suture and standard bio composite medial row anchors, was 18.9% (19).

We observed significant improvements in shoulder function outcome scores at the final follow-up (mean: 15 months, range 12 - 24). The final follow-up Constant and Oxford scores in our series reach 78/100 and 44/48 respectively. There were similar magnitudes of improvements in range of motion (both abduction and rotation), pain score and supraspinatus strength at final follow-up. Our final follow-up Constant Score is similar to that reported by other authors with all-suture anchors (16,17,20,21). Additionally, when comparing follow-up Constant Scores of patients undergoing all-suture anchor

RC repair with those repaired with standard anchors, no significant difference was found by Ro et al in 2019 and the magnitude of improvement was similar to that reported with standard anchors (16). Interestingly, we also observed improvements in outcome scores which were already statistically significant at 3 months. This is in contrast to Hughes et al study, where significant improvement in Constant Score was only seen at 6 months post rotator cuff repair with standard anchors (22).

We found that in patients with additional subscapularis tears (which were repaired) the improvement in VAS pain score was not as good as in those without at the final follow-up (although there was still a significant improvement). As far as other outcome scores are concerned, there were no differences in those with additional subscapularis tears and those without. Younger age was also associated with better outcome scores. There were no other significant correlation between other variables (demographics, preoperative and postoperative MRI findings) and changes in clinical score. In particular, there were no correlations between the size of the tear and fatty degeneration and outcome scores (although correlation with fatty degeneration almost reached statistical significance level; *P=0.07*).

Using Kim's classification to look at cyst formation on T2-weighted MRI images, we observed no fluid or minimal fluid collection in 85% of the patients (17 cases). Grade 4 changes, with encapsulated changes around the anchor with diameter larger than twice the anchor diameter, were not witnessed in any of the patients. However, we did detect grade 3 changes (fluid collection around the entire length of the anchor, with diameter less than twice the anchor diameter) in 3 patients (15%). There was no correlation between the grade of bone change and the clinical outcomes. This is similar to the findings of Van De Bracht et al, where a local collection of fluid that was not encapsulated was seen in 10.4% of patients who had rotator cuff repair with all-suture anchors, and to that reported by Ro et al where peri-anchor cyst formation was seen in 9% of the patients (16, 17). Additionally, in a more recent study, peri anchor cyst formation was witnessed around only 10.8% of all-suture anchors as compared to 41.7% of the PEEK anchors (19). These reports and our findings are in contrast to the animal study of Pfieffer et al where large cysts were reported and concerns were raised about clinical failure of all-suture anchors although this was only 8 weeks post-insertion of the anchors (22). It also important to mention that it may be difficult to distinguish between an active post-insertion process that causes tunnel widening over time, from that which is involved at the initial (time 0) all-suture anchor deployment and expansion (17). Furthermore, it has been shown that when using all-suture anchors for rotator cuff repairs, although minimal settling of the anchor may occur in patients with lower bone mass density, no further settling occurs past a certain distance from the cortex and this minimal anchor settling does not appear to have any clinical significances nor any influence of rotator cuff repair healing rates (17).

The "shoulder community", just like other specialties of medicine, are driven by a motivation to continuously improve patient outcomes through the latest technological advances both in technique and instrumentation. This also applies to management of patients with rotator cuff tears, where today arthroscopic rotator cuff repair has consistently been shown to be associated with good clinical outcomes (1). Despite the huge advance in arthroscopic rotator cuff surgery, healing rates remain compromised in patients over the age of 60 and although good clinical outcomes are generally reported even in those with re-tears, patients with healed repairs appear to do better (1). This offers a justification for seeking further technological strategies which may enhance tendon healing and improve outcomes, including those related to the modernization of implants used such as anchors and we have made tremendous progress since the first anchors, which were essentially headless hex screws attached to suture (23, 24). These advances have meant that anchor pull out and complications are no longer the main issue on those with failed healing. All-suture anchors are the latest generation anchors which may improve outcomes by offering bone preservation, greater surface contact area between bone and tendon, and more space for point of fixation when repairing massive tears. However, the concerns raised with these anchors include compromised biomechanical properties, micromotion and gap formation, all of which could potentially have a negative influence on both clinical and radiological (tendon healing) outcomes (25).

Our study shows that when using all-suture anchors for rotator cuff repairs, a small percentage of patients may develop fluid collection around the anchor with less than twice diameter of the anchor (grade 3 changes) but this does not appear to adversely influence clinical outcomes nor tendon healing rates. Therefore it is acceptable to conclude that it is safe to use all-suture anchors as medial-row anchors when performing double-row anchor transosseous equivalent rotator cuff repairs and the possible advantages of all-suture anchors may outweigh their perceived disadvantages.

There are a number of limitations with our study. It is not a randomised controlled trial, therefore although are healing rates and clinical outcomes are good, from our study we cannot deduct how they compare to those of rotator cuff repairs performed with standard anchors. Furthermore, our series only consists of 22 patients with a mean follow up of 15 months. Additionally, not all all-sutures anchors are the same as there are now different generations of these anchors so our findings here may not apply to other all-suture anchors. Nevertheless, to the best of our knowledge, this is the only study that has analysed both clinical and radiological outcomes in a series of patients who have undergone a standard transosseous equivalent double-row rotator cuff repair using all-suture anchors as medial-row anchors and classical lateral-row anchors in the second row. Furthermore, it also sheds light into rotator cuff repair recovery following repair with all-suture anchors as it reports outcome scores as early as 3 months post-

surgery. In our opinion, this report provides further evidence that all-suture anchors can be used safely when performing double-row transosseous equivalent rotator cuff repairs.

Good clinical outcomes may be achieved with transosseous equivalent double-row rotator cuff repairs using all-suture anchors as medial-row anchors. Significant improvements in outcome scores are witnessed as early as 3 months post surgery. Healing failure rates appear to be low.

In conclusion, a small percentage of patients may develop fluid collection around the the anchor with less than twice diameter of the anchor (grade 3 changes) but this does not appear to adversely influence clinical outcomes nor tendon healing rates. Therefore it is acceptable to conclude that it is safe to use all-suture anchors as medial-row anchors when performing double-row anchors transosseous equivalent and the possible advantages of all-suture anchor may outweigh their perceived disadvantages in rotator cuff repair surgery.

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