Arthroscopic transosseous versus suture anchor repair: clinical outcomes in patients with bilateral rotator cuff tears

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The aim of our study was to define if Arthroscopic Transosseous Rotator Cuff Techniques should have comparable results to those of the suture-anchors technique in a single row configuration. We reported the preliminary results of a consecutive population of 22 patients who underwent a rotator cuff treatment on the left and right sides for average medium-sized thickness tears with minimal fatty infiltration with the two different techniques: transosseous rotator cuff repair technique on one side and single row with suture-anchors on the other side, in different times. Subjective evaluation with DASH questionnaires, Constant Scores and Numerical Rating Scale (NRS) for pain evaluation, have been submitted pre and postoperatively after both operations. A statistical analysis was performed to assess the superiority of one technique and to compare pre and postoperative ROM data and clinical outcomes. A transosseous rotator cuff repair was performed in 7 patients on the dominant arm, while the other 15 patients had dominant arm cuff tear lesions repaired by using suture-anchors technique. At last follow-up a significant improvement, in shoulder pain and function, was referred at both sides. Also, DASH, Constant Scores and NRS for pain evaluation improved with both techniques, but no statistical difference was found between them. Arthroscopic transosseous rotator cuff repair technique shows comparable results to those of the suture-anchors technique in a single row configuration.

Rotator cuff tears are the most common shoulder disorders and can be degenerative or traumatic (1). Anatomic studies of rotator cuff tears in cadavers have noted a prevalence ranging from 17% to 72% (2, 3). Rotator cuff repair is one of the most common surgical procedures performed on the shoulder, the benefits of which are well known (4). Surgical management has shown predictable pain relief and functional improvement, with good overall patient satisfaction (5).

For many years open rotator cuff repair, first described by Codman in 1911, was considered the gold standard of surgical management for full-thickness tears (6). Open repair with transosseous fixation has shown good to excellent long-term clinical outcomes (7, 8) and is well supported in a variety of biomechanical studies (9). Nowadays, excellent fixation strength and outcomes have been obtained by arthroscopic rotator cuff repair (10), a technique which has increasingly been adopted in surgery. Some of the adventages are preservation of the deltoid origin and decreased postoperative pain and stiffness, the opportunity to study the entire glenohumeral joint for associated pathologies and

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the ability to fully characterize tear patterns (11-13).

The use of suture anchors for fixation of the rotator cuff tendons to the bone has become the gold standard of arthroscopic rotator cuff repair. In the literature, a variety of fixation techniques and configurations have been described, ranging from single-row (SR), to double-row (DR) and to double-row transosseous equivalent (TOE) (14). To date, the ideal method of rotator cuff repair remains unknown, since using many anchors for a valid repair increases surgical time and implant costs.

The search for improved methods recently led to the development of an all-arthroscopic transosseous (TO) rotator cuff repair technique (2), the aim of which is to replicate the open transosseous repair fixation method while conferring all the advantages of the arthroscopic technique (9). There are few data regarding outcomes after arthroscopic TO rotator cuff repair, but early published reports have been promising with similar conclusions to those on anchor-based techniques (15, 16). To date there are no comparative clinical studies evaluating outcomes after either arthroscopic anchor-based or transosseous rotator cuff repair.

We report the preliminary results of a consecutive population of patients who underwent rotator cuff treatment using two different techniques: transosseous rotator cuff repair technique on one side and the single row with suture-anchors technique on the other. Both were performed at different times.

MATERIALS AND METHODS

Between June 2011 and October 2015, we identified 22 patients who had been operated on both shoulders with the two different techniques, an overall total of 44 rotator cuff tears. All patients presented a primary rotator cuff tear on the right shoulder that presented on the left shoulder after an average delay of 3 years. There was a minimum period of 9 months between the two procedures (average 3 years). All patients presented a history of shoulder pain on both sides, associated with limited movement that did not respond to conservative treatments such as physiotherapy, NSAIDs, or corticosteroid injection.

The patients and the operative techniques were chosen in a consecutive series and were prospectively enrolled and evaluated. Dominant arm cuff tear lesions were repaired by the transosseous rotator cuff repair technique in 7 patients and by anchors in a single row configuration in 15 patients (Table I). All procedures were performed by our senior author. Subjective evaluation was obtained for both procedures using DASH questionnaires and Constant Scores, submitted pre- and, post-operatively and at follow-up (average ±3 years 6months) (range 2-5). Numerical Rating Scale (NRS) was obtained before surgery and at three months intervals post-operatively.

MRI was performed pre-operatively to determine the type of tear and the amount of fatty infiltration in the torn rotator cuff tendon. The patients were classified as retraction and infiltration average grade 2 according to Fuchs (17). Patients with gleno-humeral arthrosis, previous humeral fractures, revision rotator cuff repair, adhesive capsulitis or neurological arm deficit were excluded from the study. A tenotomy of the LHB was performed in all cases.

All post-operative outcomes were classified depending on Constant scores: excellent (90-100), very good (80-89), good (70-79) and fair (60-69). Fifteen subjects underwent MRI at two years follow-up.

Surgical technique

All the arthroscopic rotator cuff repairs were performed in the lateral decubitus. Three classical portals were used in the procedures; routine diagnostic arthroscopy was followed by subacromial decompression/bursectomy. Tenotomy of the biceps at supraglenoid tubercle was performed in case of fraying, tenosynovitis, or instability of the tendon. After subacromial decompression, footprint preparation and appropriate release of the rotator cuff, intersecting transosseous bone tunnels were created using the Taylor System.

The number of tunnels was determined at the time of surgery based on the tear size and the number of tendons torn. One transosseous tunnel per centimeter of tearing in the sagittal plane was performed. The size of the tear in the coronal plane (i.e. amount of retraction) does not typically influence the number of tunnels used for the repair. Our preference is to shuttle three high-tensile strength sutures through each tunnel: two #2 Orthocord® (Ethicon, Somerville, NJ) semi-permanent sutures and one #3-4 Force Fiber™ (Tornier, Edina, MN) permanent suture. The sutures were passed through the rotator cuff using a combination of anterograde/retrograde delivery

technique, retrieved and tied in either a simple, XBOX or mattress configuration. No bone augmentation device or patch augmentation was used in any patient in this study (Fig. 1).

In the rotator cuffs repaired using the suture-anchors technique, a standard procedure with a single row configuration was performed, with an average of 2 anchors in an Alex-stich configuration (18) (Fig. 2).

Post-operative treatment

Postoperatively, all the shoulders were placed in an arm sling with abduction pillows for five weeks, regardless of tear size. Immediate passive and active-assisted elbow/wrist/hand motion and scapular kinetic exercises were started the day after surgery. Supervised physical therapy was initiated within the first 7-10 days after surgery. Immediate supine passive anterior elevation and external rotation was performed for the first six weeks. Active ROM was started at two months after the removal of the sling and gentle strengthening typically began by week twelve. Full release to all activities is patient specific but is generally allowed at six months after surgery. Internal Review Bord (IRB) approval was obtained before the start of data collection. Written informed consent was obtained from all patients included in the study.

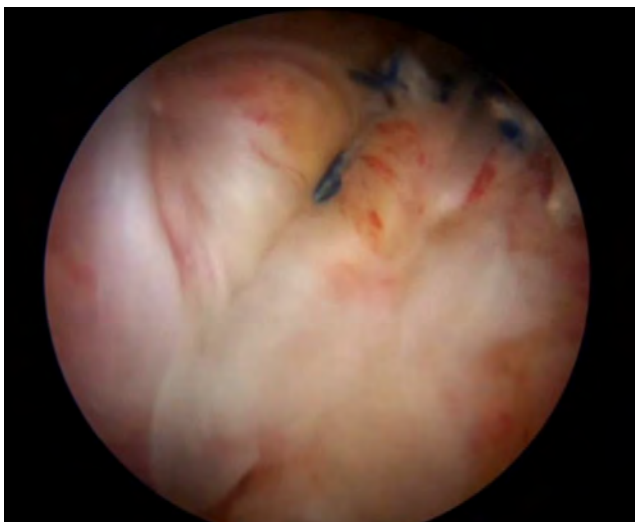

Fig. 1. *Arthroscopic transosseous suture at the end of the procedure of rotator cuff repair.*

Fig. 2. *Arthroscopic repair with Alex-stitch suture of rotator cuff tear.*

Statistycal analysis

A statistical analysis was performed to assess the superiority of one technique and to compare ROM data and clinical outcomes pre- and post-operatively and at 42 months follow-up. All patient information was reported in our database in a standardized form. Completed forms were computerized in a database created by File Maker Pro. Data were analysed by STATA MP11 software. Sample size calculation was carried out based on preliminary data on the trend of Constant Score mean values at the times of follow-up and by considering a 5% margin of error and a 95% confidence level. A minimum sample of 15 cases were confirmed.

Qualitative variables were expressed as proportions using the Chi-Square test for comparison and expressed as a mean with a standard deviation. The Student's t test for paired samples was used to compare the means at different times. The level of significance was set at $p<0.05$.

RESULTS

In this prospective study of 44 shoulders all 22 patients were evaluated. Twenty (91%) patients were males and 2 (9%) were females, the average age at the time of surgery was 57 years for the anchor group (SA) and 61 years for the transosseous group (TO).

Of the 22 shoulders treated with the TO technique 7 (32%) were on the dominant arm whereas of the 22 shoulders treated with the SA technique 15 (68%) were on the dominant arm.

An average follow-up was 42 months (9-75 months). For the anchor group (SA), the average follow-up

was 45 months (9-75), while for the TO group it was 40 months (9-70).

The lesions were medium sized (supraspinatus and infraspinatus) in 30 shoulders (15 in the SA group and 15 in the TO group) and small sized (only supraspinatus) in 14 shoulders (7 in the SA group and 7 in the TO group). The retraction and the infiltration grade according to Fuchs and Goutallier was average grade 2 (range 1-3) in both groups (17, 19).

At the last follow-up a significant improvement, in shoulder pain and function were referred for both sides. Compared to the pre-operative situation, passive glenohumeral joint range of motion improved in both the anchors and the transosseous group in all directions, according to individual parameters that made up the Constant scores.

The mean values for preoperative DASH scores and Constant Scores for the transosseous operated sides are 45.8 and 41.7 (n.s.) respectively. The mean value for pain in the preoperative NRS is 8.2 in the TO group and 8.5 in the suture-anchors group (n.s.).

Postoperatively both improved as follows: DASH 12,9 and Constant Score 73.8 ($p<0.01$). At 3 months NRS for pain evaluation was 3.1 for the transosseous group and 3.3 for the suture-anchor group (n.s.). Conversely, for the suture-anchor techniques, the mean value of DASH scores was 46.2 preoperatively and 9 postoperatively ($p<0.01$) while the Constant Score was 42.8 and 83.5 respectively ($p<0.01$) (Table II).

There was no statistical significance between the two techniques used. A statistically significant improvement was demonstrated on both techniques for ROM, DASH and Constant Scores before surgery and at the final follow-up ($p<0.01$). MRI at follow-up was performed in 15 patients demonstrating good healing of the tendons regardless to the technique used.

DISCUSSION

Transosseous rotator cuff tear repair, described by McLaughlin in 1944 (20), has represented the gold standard for years. The advent of arthroscopy has brought a new framework in rotator cuff surgery, supported by the introduction of many devices for fixation over the past few years: screwed or impacted anchors, made of different materials, can be arranged using many different types of repair configurations (21). SR, DR and TOE anchor-based repair methods are well-described in the literature and have consistently demonstrated good clinical outcomes and healing rates (22). However, shortcomings remain with this technique, such as difficulty with revision surgery, due to the presence of anchors in the greater tuberosity, anchor dislodgement, knot

Table I. *Dominant and non-dominant arms of patients enrolled in the two groups Transosseous group (TO) and Suture-anchors group (SA).*

	Dominant arm	Non dominant arm
TO	7	15
SA	15	7
Total	22	22

Table II. *No statistically significant difference in clinical scores between the two groups:p>0.05.*

	Dash score preop	Constant preop	NRS preop	Dash postop	Constant F.U.
SA	46.2	42.8	8.5	9	83.5
TO	45.8	41.7	8.2	12.9	73.8

impingement (16) and, eventually, greater tuberosity bone osteolysis (23).

Arthroscopic transosseous technique has been developed to overcome these limitations, combining the minimal invasiveness of the arthroscopic procedures with the biomechanical advantages of the open procedures (2). A further advantage of the arthroscopic transosseous technique should be the possibility of releasing stem cells and growth factors from the bone tunnels to improve tendon healing (24). Few studies regarding clinical outcomes have been published recently (15, 16, 22) but none compare the clinical results of arthroscopic anchor vs transosseous technique. We identified a unique group of 22 patients who underwent rotator cuff tears surgery between 2011 and 2015 with both techniques performed by the same senior surgeon. All patients firstly underwent an anchors rotator cuff repair in a single row configuration on one side and subsequently a transosseous repair on the other.

As Flanagin et al (22) reported in their recent paper, for the objective data, we also found an improvement in ROM in all planes in both shoulders. In both cases subjective outcomes improved but no statistically significant difference was detected between the two techniques.

DASH score for physical function and symptoms in the upper limb revealed an improvement from 45.8 to 12.9 ($p<0.01$) in the transosseous shoulders and from 46.2 to 9 ($p<0.01$) in the anchor one.

Constant scores improved in all elements from pain to daily activity and strength.

According to the Constant scores for the shoulder treated using the transosseous technique, results were excellent in 11 patients, very good in 7, good in 3 and fair in 1. For the shoulders treated with the suture-anchor technique the results were excellent in 10, very good in 9, good in 2 and fair in 1 patient. Patients were not able to appreciate any subjective difference comparing the results in both shoulders.

In a recent perspective randomized controlled trial by Randelli (25) postoperative pain decreased more quickly after the transosseous procedure, but this data was not confirmed by our study. Our paper avoids a possible bias of a subjective evaluation of pain, because the same subjects were operated on both shoulders.

In our population no significant complication was observed. Tunnels breakages were not reported, because this device placement is located about 15-20 mm distally to the greater tuberosity, in a region with a good bone stock (15). Furthermore, no intraoperative fractures of the greater tuberosity were encountered in this series.

One strength of the study is that it is the first to compare the two techniques in the same subjects. The limitations of the study are the small sample of subjects and the short follow-up. The low number of patients is correlated to the singularity of the population study. However, this also permits a subjective patient evaluation as regards both techniques. The short MRI follow-up does not confirm the presence of a postoperative re-tear.

Arthroscopic transosseous rotator cuff repair technique leads to significant short-term improvement and satisfactory subjective outcome scores with low complication/failure rates (26-28). More comparative outcome studies following either transosseous or anchor-based arthroscopic rotator cuff repairs with longer follow-up and larger samples are needed to confirm any qualitative difference in the two techniques.

Compliance with ethical standards

All procedures performed for this study were in accordance with the Ethical Standards of the Institutional and National Research Committee and with the Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board of our Institute. Written informed consent was obtained from all people included in the study.

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