

# Arthroscopic Transosseous Repair of Rotator Cuff Tear and Greater Tuberosity Cysts



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**Purpose:** To evaluate the short-term outcomes of rotator cuff repair in the presence of a greater tuberosity cyst (GTC) using a transosseous repair technique. **Methods:** This study included patients who underwent arthroscopic rotator cuff tear repair with a transosseous technique and were evaluated clinically and by postoperative magnetic resonance imaging (MRI) after 1 year. The inclusion criteria were based on the results of preoperative MRI and were as follows: patients identified as having a repairable full-thickness rotator cuff tear associated with the presence of cystic changes at the tendon insertion site of the greater tuberosity, defined as a GTC involving the footprint area of the torn tendon (supraspinatus and/or infraspinatus tendons). **Results:** We evaluated 25 patients. The mean preoperative and postoperative American Shoulder and Elbow Surgeons scores were 39.48 ( $P = .530$ ) and 84.64 ( $P = .035$ ), respectively; Constant shoulder scores, 38.96 ( $P < .005$ ) and 80.28 ( $P = .425$ ), respectively; and University of California–Los Angeles shoulder rating scale scores, 10.6 ( $P = .045$ ) and 29.04 ( $P = .315$ ), respectively. The GTC mapping system was easily adopted in all the MRI examinations independently from the quality of the images. The GTCs were mostly located in the superficial anterolateral section of the humeral head and in both the posterolateral sections (superficial and deep). **Conclusions:** Arthroscopic transosseous rotator cuff repair led to significant mid-term improvement and satisfactory subjective outcomes with low complication and failure rates in this study. The GTC mapping system could be useful to evaluate GTCs and to aid surgeons in the choice of the best surgical technique. **Level of Evidence:** Level IV, therapeutic case series.

Greater tuberosity cysts (GTCs) are often observed in patients with rotator cuff tears (RCTs), with a reported prevalence of 9%.<sup>1</sup> The cysts are occasionally encountered in the anterior (supraspinatus tendon insertion) or posterior (infraspinatus tendon insertion) aspect of the greater tuberosity or in the lesser tuberosity (subscapularis tendon insertion). The

anterior location of a cyst is strongly associated with a full-thickness RCT<sup>2</sup> regardless of age.<sup>1</sup> The etiopathogenesis of these cysts is still not completely understood, and several explanations have been reported. They can arise from congenital abnormalities, age-related degeneration, or rotator cuff (RC) pathology.<sup>2-4</sup> The intact tendon insertion may protect against cyst formation by attaching firmly to bone that creates a barrier for the synovial fluid.<sup>5</sup>

In most cases, the cysts are small and do not interfere with RCT reattachment.<sup>6</sup> In this scenario, placing the tendon stump onto the cyst area or medializing the tendon reattachment allows the problem to be easily overcome. However, when a cyst is large enough and in a critical location, its presence poses a serious challenge during arthroscopic RCT repair.<sup>6</sup> These GTCs may encompass such a large area of the RC footprint that suture anchor fixation can be compromised.<sup>6</sup> Moreover, bone deficiency decreases the biological healing capability of the tendon, particularly in elderly patients.<sup>3,7</sup> For these reasons, several surgical techniques have been described in the literature for RCT repair associated with large bone cysts.<sup>6-9</sup> Some authors prefer a 2-stage procedure in which initial bone grafting is followed 3 months later by RCT

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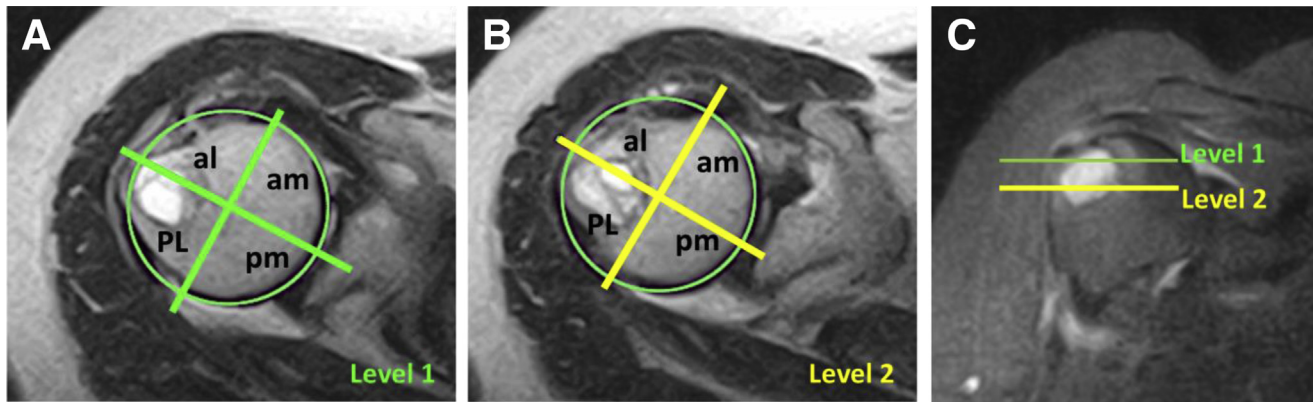
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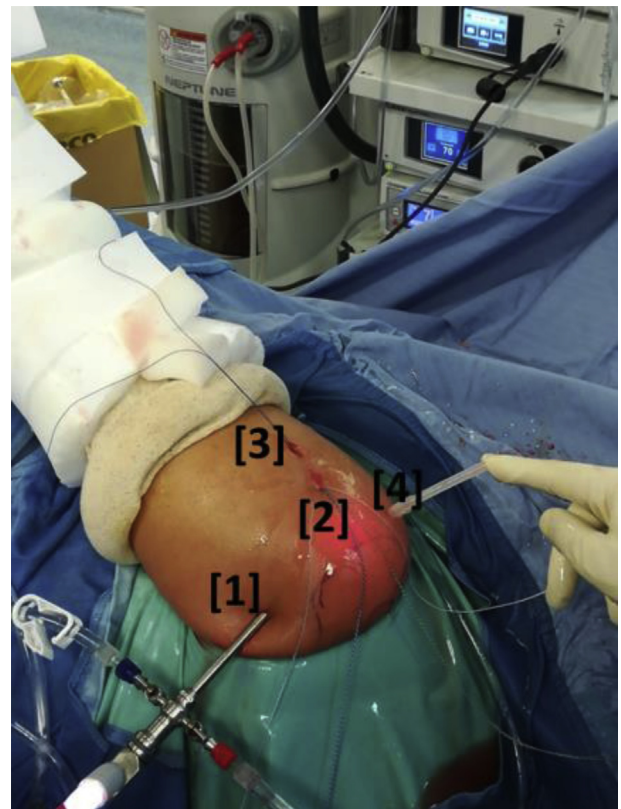
**Fig 1.** Magnetic resonance imaging showing greater tuberosity cyst mapping system. (A, B) Axial views of level 1 (green), placed at the footprint, and level 2 (yellow), placed 10 mm below. (C) Coronal view showing levels 1 and 2. The humeral head is divided into 4 sections, named using uppercase letters (major width of the cyst in the section) and lowercase letters (minor width of the cyst in the section). In this case, the cyst mapping was “PL1PL2,” suggesting a prevalent posterior location of the cystic bone reabsorption. The cyst area was 3.2 cm<sup>2</sup> at level 1 and 2.4 cm<sup>2</sup> at level 2. (al, anterolateral; am, anteromedial; PL, posterolateral; pm, posteromedial.)

repair.<sup>8</sup> Other authors have described a 1-stage procedure using compaction bone graft with either allogeneic or autogenous bone to fill the greater tuberosity defect during arthroscopic reconstruction, fixing suture anchors to the bone graft itself and enhancing their graft anchor fixation with additional anchors placed into native bone.<sup>6</sup>

However, many disadvantages have been associated with the use of autograft and allograft, including donor-site morbidity, nonunion, collapse, and resorption of the graft. In addition, the risk of suture anchor pullout from the grafted bone, as well as potential graft necrosis, has been mentioned.<sup>6</sup> To address the bone defect, overcoming the problems related to the bony allograft or autograft, a 1-stage arthroscopic technique using a synthetic graft and placing suture anchors distal and lateral to the cuff footprint was described.<sup>9</sup>

In an attempt to overcome the limitations of anchor repair, arthroscopic transosseous (TO) RC repair techniques have been developed.<sup>10-12</sup> In case of bone deficiency of the greater tuberosity, it is possible to use a lateral cortical augmentation device that is able to protect and reinforce the bone itself,<sup>13</sup> without any need to medialize the tendon insertion.<sup>14</sup>

Several studies have shown that TO tunnels provide an excellent hold. In addition, TO repairs are associated with a higher load to failure and yield less interference motion than suture anchors.<sup>15,16</sup> The purpose of this study was to evaluate the short-term outcomes of RC repair in the presence of a GTC using a TO repair technique. The hypothesis was that the TO technique would be a good alternative for fixing an RCT in the presence of an unfavorable condition, such as a GTC.



**Fig 2.** Arthroscopic portals (external view) in a left shoulder with the patient in the lateral decubitus position. The 4 portals are as follows: (1) a standard posterior portal for the scope; (2) a superolateral portal centered on the lesion and tangential to the greater tuberosity; (3) an inferolateral portal placed 2 cm below the superolateral portal, which permits the entrance of a dedicated instrument to create the transosseous tunnel; and (4) an anterosuperior (working) portal.



**Fig 3.** The Taylor Stitcher Evo is a dedicated instrument able to create, with the aid of a nitinol Superelastic Transosseous Needle (1.9 mm in diameter), a curved transosseous tunnel and, at the same time, pass the suture or a shuttle. The instrument consists of 2 arms: The inferior arm is fixed, whereas the superior arm is a sliding targeting frame that permits easy orientation in the shoulder together with proper identification of the lateral entry spot without measuring it in advance. A bone bridge of 18 to 20 mm is provided.

## Methods

### Patient Population

The study was designed in a retrospective manner. Prior conservative treatment had failed in all included patients. The inclusion criteria were based on the results of preoperative magnetic resonance imaging (MRI) and were as follows: patients with a repairable full-thickness RCT associated with the presence of cystic changes at the tendon insertion site of the greater tuberosity, defined as a GTC involving the footprint area of the torn tendon (supraspinatus and/or infraspinatus tendons). Patients with previous shoulder surgery, injections, infection, glenohumeral instability, symptomatic acromioclavicular joint pathology, arthritis, and/or stiffness were excluded from the study.

Patient-centered outcome scores were collected preoperatively and postoperatively at 1 year. These included the American Shoulder and Elbow Surgeons (ASES) score,<sup>17</sup> Constant shoulder score,<sup>18</sup> and University of California—Los Angeles (UCLA) shoulder rating scale.<sup>19</sup>

### Magnetic Resonance Evaluation

Preoperative MRI was analyzed to determine (1) the involved ruptured tendon(s), (2) the amount of fatty infiltration of the torn RC tendon(s) according to the staging system of Fuchs et al.,<sup>20</sup> and (3) the location and dimension of the GTC. To elucidate the latter point, a reproducible cyst mapping system was developed: the GTC mapping system.

The GTC mapping system identifies cyst depth on the greater tuberosity and has to be performed on 2 axial T2-weighted images with or without fat suppression at the level of footprint and 10 mm below. On both slices, a best circle is placed along the humeral head margins on the axial images, and a horizontal line is placed within the center of the circle and extends onto half of

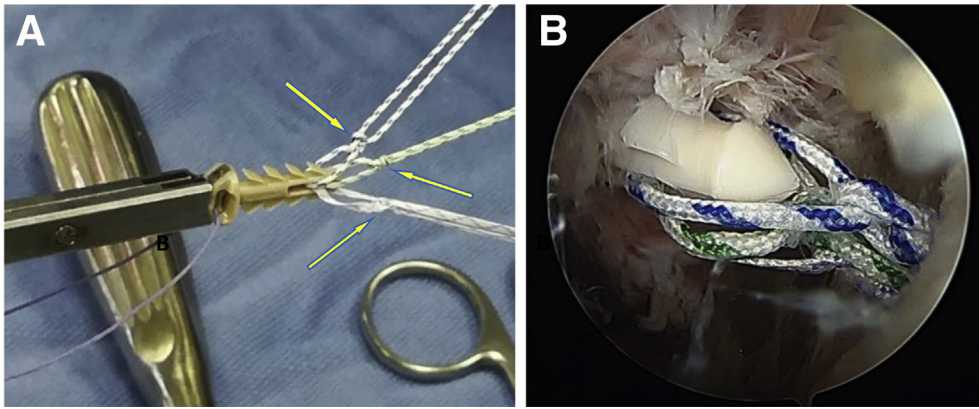
the humeral greater tuberosity (at the 12-o'clock position on the greater tuberosity). A second line, orthogonal to the first one, passing through the center of the circle, is then drawn. The greater tuberosity is divided into 4 sections for each level, in which "A" is anterior, "P" is posterior, "M" is medial, and "L" is lateral: AM, AL, PM, and PL. A number follows these letters, indicating the level: "1" is for the superficial level (at the footprint), or level 1, and "2" is for the deep level (corresponding to 10 mm below level 1), or level 2. Uppercase letters indicate a prevalent width of the cyst in the section, whereas lowercase letters indicates a minor width or absence of the cyst in the section on the axial images (Fig 1). The system also permits the entire axial area of the cyst to be easily measured.

Postoperatively, MRI was reviewed to determine (1) the tendon healing process and (2) any modifications in dimension (enlargement vs reduction) of the cyst. The preoperative images were obtained on a 0.3- or 1.5-T magnet in every patient at different radiologic centers (if axial T2-weighted images were not available, patients were not enrolled), whereas all the postoperative examinations were performed 1 year after surgery at a single center with a 1.5-T magnet using routine pulse sequences.

All the images were reviewed by 2 of the authors: a musculoskeletal radiologist with expertise in shoulder pathology (M.O.) and an orthopaedic surgeon dedicated to the shoulder (C.C.). The interobserver agreement was determined, with a  $\kappa$  coefficient<sup>21</sup> of 0.85.



**Fig 4.** Transosseous tunnel preparation in a left shoulder with the patient in the lateral decubitus position. The scope is in the posterior portal, and the subacromial space is shown. The shuttle wire (No. 0 polydioxanone, arrow) is transported through the transosseous tunnel by the Superelastic Transosseous Needle.



**Fig 5.** Lateral cortical augmentation. (A) The Elite-SPK contains 2 separated eyelets: a rear eyelet that remains externally on the lateral cortex of the humerus and a front, smaller eyelet through which sutures are initially loaded. Along the body of the device, 8 stabilizing flaps are attached to the main body; in combination with the wide supporting platform, these flaps have the function to provide optimal primary stability to the implant. Three sutures of different colors (1 white-and-blue suture, 1 white-and-green suture, and 1 tape) were passed. Before this step, to avoid any sliding of the sutures, 2 simple knots (arrows) were performed for each one, in the front part of the implant. (B) Entrance of Elite-SPK in a left shoulder with the patient in the lateral decubitus position. The scope is in the posterior portal, and the subacromial space is shown.

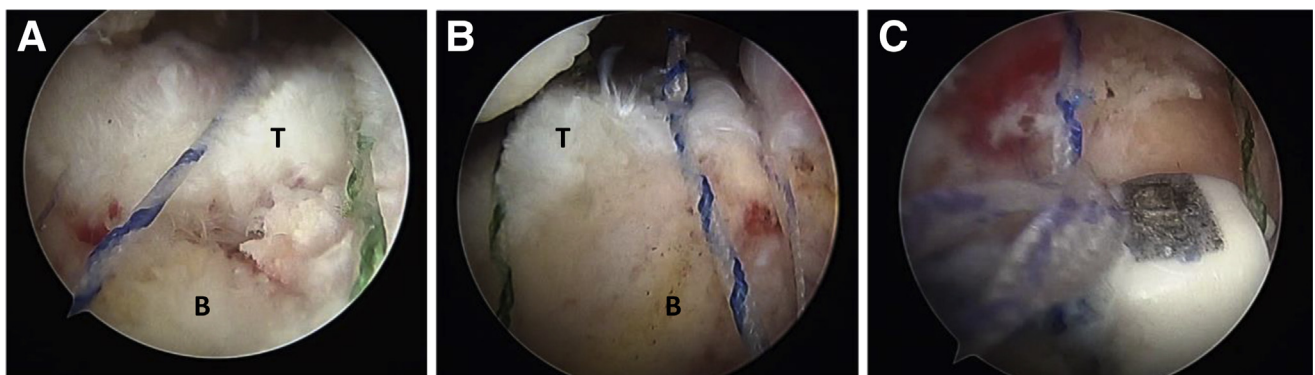
### Surgical Technique

All procedures were performed by the first author with the patient in the lateral decubitus position with an interscalene cervical plexus block according to Alemanno et al.<sup>22</sup> A 4-portal surgical technique without cannulas was used, comprising standard posterior (for the scope), superolateral, inferolateral, and anterosuperior (working) portals (Fig 2). The superolateral portal was centered on the lesion and tangential to the greater tuberosity. The inferolateral portal was placed 2 cm below and permitted the entrance of a dedicated instrument called the Taylor Stitcher Evo

(NCS Lab—Medical Devices Factory, Carpi, Italy) (Fig 3) developed to create the TO tunnel while avoiding pitfalls and damage to the soft tissues.

Once the reparability of the RC was assessed, the possible associated pathologies were treated first (subscapularis repair and tenotomy or tenodesis of the long head of the biceps). The tendinous and bony sides of the lesion were accurately prepared, the cuff was adequately mobilized, and the tendon margins were refreshed.<sup>23</sup>

The greater tuberosity was carefully prepared to maximize RC footprint coverage. A wide surface



**Fig 6.** Final arthroscopic view in a left shoulder with the patient in the lateral decubitus position. The scope is in the lateral portal (from superior in A and B and from inferior in C), and the subacromial space is shown. All the sutures are tied and closed in the lateral eyelet of the Elite-SPK. (B, bone; T, tendon.)

**Table 1.** Postoperative Rehabilitation Program

Period	Aim	Activity
First stage: from immediately postoperatively until fourth week	Prevent articular stiffness	Passive exercises in abduction, front flexion, and ER (passive ER limited to 0° if subscapular tendon was repaired)
Second stage: from fourth week until 12th week (third month)	Achieve progressive recovery of passive ROM without scapular compensation	Assisted or active exercises at a minimum load; removal of sling
Third stage: beginning around third month (10th-12th week) and lasting until 12th week or beyond	Recover strength and physiological scapular-humeral rhythm	Toning exercises focusing on recovery of power and strength of rotator cuff tendons

ER, external rotation; ROM, range of motion.

decortication of the footprint was performed providing maximum spongy bone. In addition, four to six 1.5-mm puncture holes (bone marrow vents or microfractures) were performed to obtain the crimson duvet effect.<sup>24</sup> These vascular access channels could contribute to cuff healing<sup>25,26</sup> by increasing blood flow in the repaired RC.<sup>27</sup>

After these steps, the TO tunnel required for this technique was prepared using the Taylor Stitcher Evo. This tunnel is 3 mm in diameter and presents a smooth curved morphology. The shuttle wire was then passed in a single step with the Superelastic Transosseous Needle (STN; NCS Lab - Medical Devices Factory, Carpi [MO], Italy) (having an eyelet close to the tip) through the TO tunnel (Fig 4) so that the suture wires could be pulled through it. This shuttle is capable of pulling up to 6 suture wires connected to the front part of an implant made of PEEK (polyether ether ketone): the Elite-SPK (NCS Lab—Medical Devices Factory) (Fig 5). All 6 stitches were then passed through the cuff to obtain the “2MC” (or “double MC”) configuration with the tape ends passed more anteriorly and posteriorly.<sup>13</sup> Schematically, we refer to limb 1 as the most anterior and to limb 6 as the most posterior. We first closed limb 2 with limb 3 (suture 1) and later closed limb 4 with limb 5 (suture 2), leaving limbs 1 and 6 free. After cutting one end of suture 1 and one end of suture 2, we shuttled limb 1 and the remaining end of suture 1 from anterior to posterior in the external eyelet of the Elite-SPK. At this point, to achieve a repair with a closed-loop configuration, knots were tied (laterally) between limbs 1 and 6 (tape), as well as the remaining limbs of sutures 1 and 2. The described technique represents a very tight and stable repair configuration that permits the greater tuberosity to be almost completely covered (Fig 6).

### Postoperative Rehabilitation Protocol

The postoperative rehabilitation protocol after arthroscopic TO RC repair is designed to protect the repair in the early stages, to prevent postoperative stiffness, and to restore the function of the scapulohumeral joint.<sup>28,29</sup> Immediately after surgery, the patient wears a 15° to 20° abduction pillow, which

maintains the arm abducted without external rotation (neutral or resting position), for the first 4 postoperative weeks. This pillow is capable of protecting the repair, reducing tension at the suture level, and improving vascularization of the scar during the early weeks.<sup>30,31</sup> The postoperative rehabilitation program is conventionally divided into 3 stages that naturally overlap without any break between them (Table 1).

### Statistical Analysis

The sample size was determined a priori by imposing a power value of 90%,  $\alpha$  equal to .05, and a minimum difference in the Constant score equal to 4. The data obtained with Minitab 17 (Minitab, State College, PA) were increased by 30% to account for loss of data during the study. Descriptive statistics (mean, standard deviation, minimum, and maximum) were applied for all values. Preoperative and postoperative UCLA, Constant, and ASES scores were evaluated. Comparison of the clinical variables was performed using the dependent-samples *t* test for normally distributed data and the Wilcoxon signed rank test for non-normally

**Table 2.** Patient Demographic Characteristics and RCT Patterns

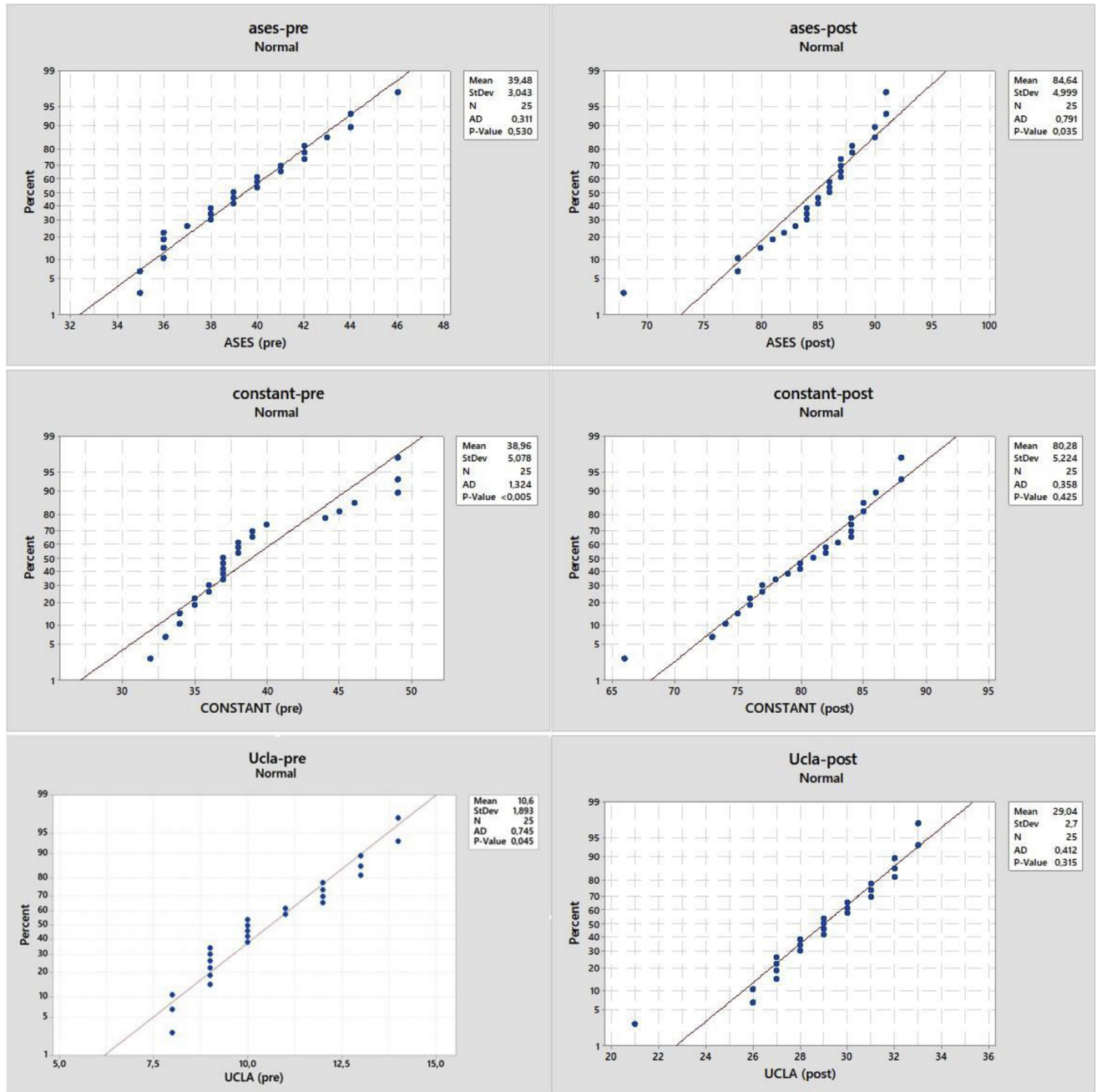
	Data
Age, mean $\pm$ SD (minimum/maximum), yr	58.4 $\pm$ 6.9 (46/75)
Male/female sex, n	13/12
Side affected: right/left (dominant), n	17/8 (20)
Tear pattern, n	
Supraspinatus	1
Supraspinatus and subscapularis	2
Supraspinatus and infraspinatus	16
Supraspinatus, infraspinatus, and subscapularis	6
Status of long head of biceps tendon, n	
Healthy	1
Pathologic (partial rupture or tendinosis)	19
Absent (spontaneous rupture)	5
Fuchs grade, n	
I	8
II	15
III	2

RCT, rotator cuff tear; SD, standard deviation.

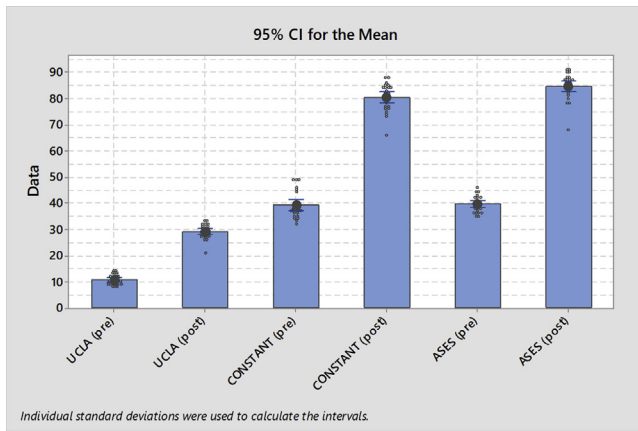
**Table 3.** Outcome Scores Preoperatively and Postoperatively

	Preoperative				Postoperative			
	Patients With Available Data, n	Mean	SD	P Value	Patients With Available Data, n	Mean	SD	P Value
ASES score	25	39.48	3.04	.530	25	84.64	5.00	.035
Constant	25	38.96	5.08	<.005	25	80.28	5.22	.425
UCLA score	25	10.60	1.89	.045	25	29.04	2.70	.315

ASES, American Shoulder and Elbow Surgeons; SD, standard deviation; UCLA, University of California–Los Angeles.



**Fig 7.** Patient-centered preoperative (pre) and postoperative (post) outcome scores. (AD, Anderson-Darling test; ases, American Shoulder and Elbow Surgeons; StDev, standard deviation; Ucla, University of California–Los Angeles.)



**Fig 8.** Ninety-five percent confidence intervals for mean patient-centered preoperative (pre) and postoperative (post) outcome scores. (ASES, American Shoulder and Elbow Surgeons; UCLA, University of California—Los Angeles.)

distributed data. Two-sided, paired Student *t* tests with 95% confidence intervals for the mean differences were computed.  $P < .05$  indicated a statistically significant difference. All analyses were performed using Minitab 17.

The *t* test was used to compare preoperative versus postoperative data. The normality test was performed on the entire postoperative data set to check for the appropriateness of the method. The null hypothesis for this study was that there would be no difference in the clinical results in the preoperative versus postoperative evaluation and in the applied treatment. Moreover, to assess the clinical relevance of the findings,<sup>32,33</sup> the minimal clinically important difference (MCID) for this trial was estimated based on the collected data according to Gum et al.<sup>34</sup> using a test-retest reliability coefficient (*r*) estimated through the Pearson correlation coefficient.

This study was conducted in accordance with the World Medical Association Declaration of Helsinki standards of 1964, as revised in 1983 and 2000. All patients were informed about the study in detail prior to providing written informed consent for enrollment.

## Results

Demographic data and the distribution of the RCT pattern within the study population are reported in Table 2. All 25 patients completed the study.

Acromioplasty was not performed in any case. No intraoperative complications were registered. All outcome scores improved at 1 year after surgery (Table 3). MCID threshold values equal to 4.81, 11.49, and 6.13 were found for the UCLA, Constant, and ASES scores, respectively. According to these values, all the patients met the MCID threshold for each clinical score, meaning that the experienced change was always clinically relevant. According to ASES scores, the results of the 25 shoulders available for final follow-up were excellent in 4 (16%), good in 18 (72%), fair in 2 (8%), and poor in 1 (4%), with mean values of 39.48 preoperatively ( $P = .530$ ) and 84.64 postoperatively ( $P = .035$ ). The mean Constant shoulder score was 38.96 preoperatively ( $P < .005$ ) and 80.28 postoperatively ( $P = .425$ ). The UCLA scores were excellent or good in 22 shoulders (88%) and fair or poor in 3 (12%). The mean UCLA score was 10.6 preoperatively ( $P = .045$ ) and 29.04 postoperatively ( $P = .315$ ). The null hypothesis of no difference in the preoperative versus postoperative scores was rejected, and the patients presented with significantly better results postoperatively (Figs 7 and 8). In only 1 case was a failure registered 1 year after surgery.

The GTC mapping system was easily adopted in all the MRI examinations independently from the quality (0.3- or 1.5-T magnet) of the images. The GTCs were mostly located in the anterolateral section of the superficial level and in the posterolateral section of both levels (Table 4, Fig 9).

Postoperative MRI examinations revealed RC repair integrity after surgery in 24 of 25 cases (Sugaya types I and II) (Fig 10) and the presence of a major discontinuity (i.e., failure) in only 1 case (Sugaya type V). The implant was stable (i.e., no device mobilization) in all patients. The cyst's size was maintained stable 1 year after surgery (i.e., no enlargement or reabsorption). Tunnel closure occurred only in the case in which the tunnel crossed healthy bone, in which there was no cyst.

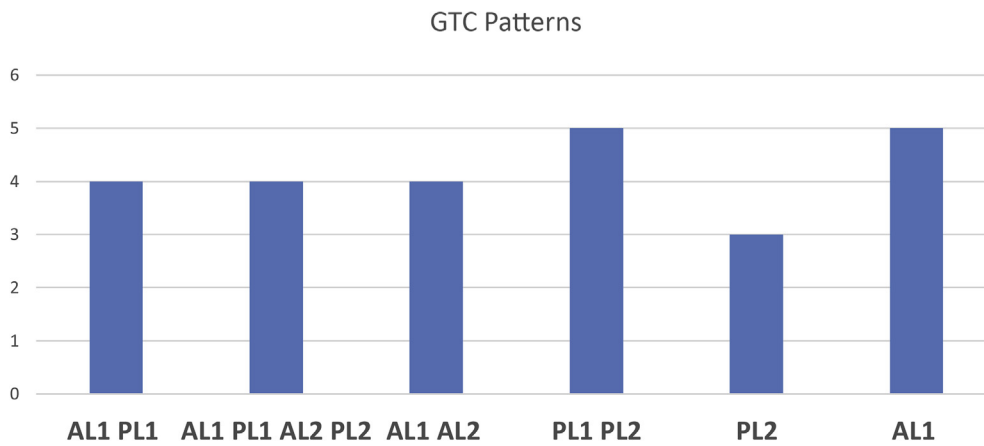
## Discussion

The presence of a bone cyst in the greater tuberosity when associated with an RCT may represent a highly demanding technical challenge. Arthroscopic TO RC repair using a lateral PEEK cortical augmentation leads to significant mid-term improvement and satisfactory

**Table 4.** GTC Mapping System Results

	No. of Cysts	Mean Area	Cyst Size, cm <sup>2</sup>	
			Minimum Area	Maximum Area
Level 1	22	1.96	0 (no cyst)	3.4
Level 2	17	1.28	0 (no cyst)	2.6

GTC, greater tuberosity cyst.



**Fig 9.** Distribution pattern of greater tuberosity cysts according to greater tuberosity cyst (GTC) mapping system, in which A indicates anterior; P, posterior, L, lateral; 1, superficial level (i.e., level 1, at the footprint) on axial view; and 2, deep level (i.e., level 2, corresponding to 10 mm below level 1) on axial view. An uppercase letter indicates a prevalent width of the cyst in the section whereas a lowercase letter indicates a minor width or absence of the cyst in the section on the axial images.

subjective outcomes with very low complication and failure rates in patients with RCTs associated with GTCs. On the basis of our investigation, the current literature on this topic includes only technical notes and case reports. Reda et al.<sup>35</sup> proposed repairing the cyst with demineralized bone matrix, using metal anchors that are placed in the area near the cyst, and eventually using an augmentation in case of massive tears. Postl et al.<sup>7</sup> used an open technique to segment the cyst lesion and repair the cuff with double-row anchor reconstruction. Agrawal and Stinson<sup>9</sup> used an Osteo-Biologics implant (San Antonio, TX) to fill the cyst; they then repaired the cuff tear.

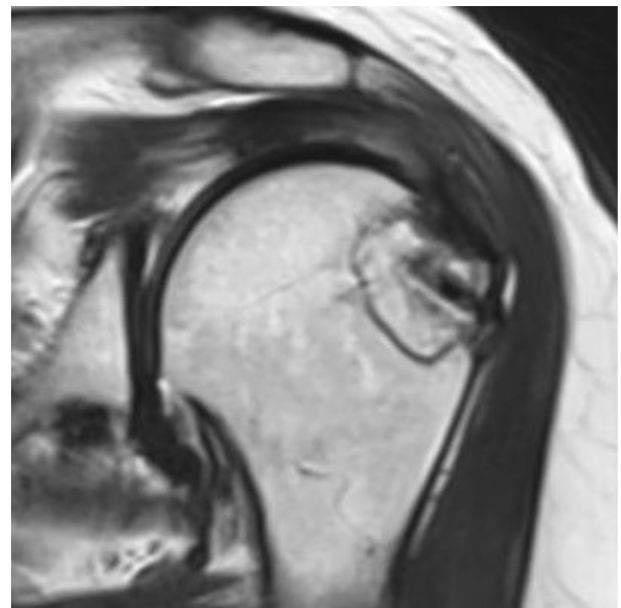
Our study was a retrospective case-series study, not only showing an all-arthroscopic TO procedure but also reporting clinical and radiologic results at 1 year. In addition, a mapping system for cysts was introduced: the GTC mapping system. This mapping system overcomes some limitations of a previous location system for GTCs,<sup>1</sup> in which the proximal humerus was divided into 2 halves by a line drawn at the 12-o'clock position on the greater tuberosity on axial and sagittal oblique images. Cysts located in the anterior quadrant were related to cuff disorder, whereas those in the posterior quadrant were not.<sup>36</sup>

This kind of classification appears to have some limitations because it is not able to precisely locate and subcategorize cysts.<sup>36</sup> The GTC mapping system, which we developed in a simple and reproducible way, is able to define the location (anterior or posterior, medial or lateral) and depth (superficial or deep) of GTCs. The exact positioning easily obtained with the GTC mapping system may help the surgeon in determining the correct choice to manage RCTs.

Different factors play an important role during the tendon healing process.<sup>37</sup> Among these, mechanical factors,<sup>38</sup> suturing techniques,<sup>39</sup> and biological factors<sup>40,41</sup> are considered the crucial points.<sup>42</sup>

In the management of RC repair, the main goals are pain relief, improvement in function, and successful

tendon healing. It has been stated that the ideal repair should have high initial strength, allow minimal gap formation, and maintain stability until solid healing occurs.<sup>38</sup> All these features are represented in the TO approach. In a previous study, the usefulness of this approach has been demonstrated for the treatment of RC failure<sup>14</sup> in which the bone is weakened by the presence of anchors.<sup>43</sup> Similarly, in our study, the TO approach appeared valid when an RCT was associated with GTCs. In this particular condition, anchor placement in a defect-free zone with good bone stock may affect the quality and position of the RC footprint reconstruction. In addition, an open technique to augment the cystic lesion with bone void filler in



**Fig 10.** Coronal TSE (turbo spin echo) T2-weighted magnetic resonance image 12 months after transosseous rotator cuff repair showing regular margins of the tendon on the bursal side with lower signal, compatible with fibrous tissue; one should note the position of the Elite-SPK with intact cystic lateral and superior walls.



combination with RCT reconstruction has been suggested, but the long-term results regarding biological integration with this material are still missing.<sup>7</sup> Most important, the evidence supporting the use of the aforementioned surgical techniques is lacking because no reports exist describing the clinical results after RCT repair in the presence of large GTCs.

### Limitations

We report short-term outcomes, complications, and technical pearls encountered in a series of 25 patients with 1 year of follow-up after arthroscopic TO RC repair associated with large GTCs performed by the same surgeon at a single institution. Complication (0%) and failure (4%) rates were extremely low, and the 1 case of failure was not associated with the surgical technique. A weakness of this study is that the consecutive group of patients presented with a heterogeneous distribution of RCTs; thus, the associated arthroscopic procedures (subscapularis repair and biceps tenotomy or tenodesis) could have served as a confounding variable.

### Conclusions

Arthroscopic TO RC repair led to significant mid-term improvement and satisfactory subjective outcomes with low complication and failure rates in this study. The GTC mapping system could be useful to evaluate GTCs and to aid surgeons in the choice of the best surgical technique.

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