



# In situ repair of partial-thickness rotator cuff tears: a critical analysis review

Luciano A. Rossi  
Maximiliano Ranalletta

- After failed conservative management, operative intervention is typically indicated for patients with partial-thickness rotator cuff tears (PTRCTs) with persistent pain and disability symptoms.
- For PTRCTs involving < 50% of the tendon thickness, debridement with or without acromioplasty resulted in favourable outcomes in most studies.
- For PTRCTs involving > 50% of the tendon thickness, in situ repair has proven to significantly improve pain and functional outcomes for articular and bursal PTRCTs.
- The few available comparative studies in the literature showed similar functional and structural outcomes between in situ repair and repair after conversion to full-thickness tear for PTRCTs.
- Most non-overhead athletes return to sports at the same level as previous to the injury after in situ repair of PTRCTs. However, rates of return to preinjury level of competition for overhead athletes have been generally poor regardless of the utilized technique.
- During long-term follow-up, arthroscopic in situ repair of articular and bursal PTRCTs produced excellent functional outcomes in most patients, with a low rate of revision.

**Keywords:** articular side; bursal side; in situ repair; long-term outcomes; partial thickness; return to sports; rotator cuff tears

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## Introduction

Partial-thickness rotator cuff tears (PTRCTs) are common causes of pain and dysfunction in the adult shoulder.<sup>1,2</sup> The reported prevalence of PTRCTs in imaging and cadaveric studies ranges from 13% to 37%.<sup>3,4</sup> Partial articular rotator cuff tears (PARCTs) are two to three times more common than bursal-side lesions and are particularly frequent in overhead athletes.<sup>5,6</sup>

Different mechanisms have been described in the pathogenesis of PARCTs, including traumatic events, age-related degenerative changes to the tendon and instability with secondary impingement.<sup>7-10</sup> Both acute trauma and repetitive microtrauma can eventually contribute to tensile overload and fibre failure of the rotator cuff.<sup>11-13</sup> Age-related microscopic changes and decreased vascularity of the tissues predispose the tendon to degenerative tearing and alterations in intratendinous microarchitecture.<sup>7-9,14</sup> Unfortunately, at present, there is no widely accepted classification system for PTRCTs. The two most widely utilized systems are the Ellman and the Snyder classifications.<sup>15,16</sup> Ellman described a classification system based on arthroscopic findings in 120 arthroscopic subacromial decompressions.<sup>15</sup> The classification is based on the location of the tear (A, articular; B, bursal; or C, intratendinous) and the depth of the tear (grade 1, < 3 mm; grade 2, 3–6 mm; and grade 3, > 6 mm). Current literature shows that grade 1 and 2 articular-sided tears can be successfully treated in the short term with arthroscopic debridement alone, whereas grade 3 tears (> 6 mm depth) should be repaired.<sup>1,2</sup> However, PBRCTs should be approached more aggressively, with debridement for grade 1 tears only and with repair for grade 2 and 3 (> 3 mm) tears.<sup>1,2</sup> Kuhn et al<sup>17</sup> evaluated the interobserver reliability of six different rotator cuff tear classification systems, including that described by Ellman, using arthroscopic video evaluations. The authors reported there was poor agreement among fellowship-trained orthopaedic surgeons in determining tear depth. Snyder et al<sup>16</sup> described a new classification system based on tear location and severity. Tears are graded on the degree of tearing on both the articular side and the bursal side. The degree of tearing is graded from 0 to IV, with 0 being normal and IV being a significant partial tear more than 3 cm in size. Recently, Lee et al<sup>18</sup> examined the interobserver reliability and accuracy of classifying partial rotator cuff tears using the Snyder classification system. For this study, 27 orthopaedic surgeons reviewed 10 video-recorded shoulder arthroscopies. The authors reported a

kappa coefficient of 0.512 which indicated moderate reliability between surgeons.

Several articles have been published recently on the management of PTRCTs.<sup>1,2,19–21</sup> This article provides a comprehensive review of current concepts pertaining to in situ repair of PTRCTs. This review specifically evaluates return to sports and functional outcomes after in situ repair of articular and bursal PTRCTs. Moreover, studies comparing in situ repair with other techniques are also analysed. Lastly, as there is no current ‘benchmark’ for their management, the aim of this review is to present a critical analysis of current options based on the authors’ personal experiences and recent available scientific literature.

## Non-operative treatment

Non-operative treatment is indicated for the initial management of PARCTs.<sup>21–23</sup> This approach includes activity modification with the avoidance of provocative activity and use of non-steroidal anti-inflammatory medications. A supervised physical therapy regimen is also indicated to stretch out the contracted posterior capsule and re-establish normal shoulder dynamics.<sup>22–24</sup> As pain decreases and motion improves, strengthening exercises focusing on the rotator cuff and periscapular musculature should be initiated.<sup>22–24</sup> Young patients, especially overhead athletes, should be informed that duration of non-operative therapy is typically two to three months before the current symptoms are resolved.<sup>23,25,26</sup> Once shoulder symptoms improve, physical therapy can progress to a sports-specific training programme.<sup>23,25,26</sup> Subacromial corticoid injections can help in the initial management of pain and facilitate patient comfort and physical therapy.<sup>27,28</sup> Before proceeding to the surgical options, generally a minimum of three to six months of conservative treatment is recommended. Kim et al,<sup>24</sup> showed that delayed surgical repair following a course of conservative treatment in partial-thickness tears did not yield worse results as compared to immediate arthroscopic repair, and, in fact, those who underwent six months of conservative treatment prior to repair showed improved functional results six months post-operatively as compared to those who underwent immediate repair.<sup>24</sup> Several clinical predictors of success of non-operative treatment have been described. Lo et al,<sup>22</sup> reported that patients with atraumatic PTRCTs, involving < 50% of the tendon thickness and the non-dominant extremity, were more likely to be successful. Nevertheless, patients should be warned that these lesions may progress in size and become symptomatic over time. Biomechanical and histologic studies have shown that once a partial-thickness lesion of the rotator cuff occurs, the tear progresses in a significant number of patients.<sup>3,29</sup> Clinical evidence shows that in the short term, a significant number of tears progress in size and become symptomatic. Recently, Keener et al,<sup>30</sup> prospectively evaluated 56 patients

with asymptomatic PTRCTs. They showed tear progression in 44% of the shoulders. The median time for progression was 2.8 years. Moreover, 49% of patients experienced pain. Therefore periodic monitoring is recommended, especially in active young patients despite successful conservative treatment.<sup>30</sup>

## Operative treatment

### Indications

After failed conservative management, operative intervention is typically indicated for patients with persistent pain and disability symptoms.<sup>1,2,14</sup> PTRCTs are typically managed according to their depth, or the thickness of the tear in relation to the tendon width.<sup>14</sup> Tears of < 50% are usually treated with debridement with or without acromioplasty. Tears of > 50% are either repaired in situ, preserving the intact layer, or converted to full-thickness tears followed by repair with an adequate technique.

### Arthroscopic debridement

Strauss et al<sup>31</sup> performed a systematic review evaluating surgical outcomes of PTRCTs following arthroscopic debridement involving < 50% of the tendon thickness. They reported that debridement with or without acromioplasty resulted in favourable outcomes. It is not clear in the literature whether functional results are better for bursal or articular PTRCTs. Some authors found superior outcomes for bursal-sided tears,<sup>32</sup> while others reported better results for articular-sided tears.<sup>33</sup> Dwyer et al,<sup>34</sup> recently evaluated the results of 76 consecutive patients with PTRCTs (40 articular, 36 bursal) treated with arthroscopic debridement and selective acromioplasty (for type II or III acromions). They reported good outcomes among patients with articular- or bursal-sided PTRCTs of < 50% tendon thickness with no difference between groups at two-year follow-up.<sup>34</sup> Although most studies show favourable outcomes in the short term, there is a chance of deterioration of good results over time. Kartus et al,<sup>35</sup> following 26 PTRCTs of < 50% for a minimum of five years, identified that nine out of 26 (35%) had a full-thickness tear on ultrasound at final follow-up.

### In situ repair of PTRCTs

There are two main proposed advantages of the arthroscopic in situ repair. First, it restores the rotator cuff footprint without sacrificing the intact fibres of the tendon.<sup>36</sup> Second, if completion of the tear and repair is chosen, after the tissue is excised, the normal tissue margin must be brought over and repaired to a lateral bone bed. This can alter the normal footprint of the rotator cuff and may potentially create a length-tension mismatch of the repaired rotator cuff muscles.<sup>36</sup> In 2017 Osti et al evaluated 18 studies

**Table 1.** Summary of studies with comparison of in situ arthroscopic repair of PTRCTs versus repair after conversion to full-thickness tear

| Authors                        | Year | Level of evidence | n of patients | Type of PTRCT | Treatment  | Main functional and structural outcomes at final follow-up   |
|--------------------------------|------|-------------------|---------------|---------------|--|--|
| Shin SJ <sup>46</sup>          | 2012 | II                | 48            | Ellman 3 A    | G1: n = 24 in situ repair<br>G2: n = 24 conversion to full-thickness and repair    | - Significant improvement in functional outcomes (ASES, Constant, VAS) in both groups without significant differences at final follow-up<br>- 92% patients satisfied with surgery in both groups<br>- Patients in G1 had significantly more pain (5.9 ± 0.4) than patients in G2 (2.8 ± 0.5) (P = .001) until three months after surgery<br>- No statistical difference in re-tear rates between groups: 100% and 91% for G1 and G2 respectively |
| Franceschi et al <sup>47</sup> | 2013 | II                | 60            | Ellman 3A     | G1: n = 32 in situ repair<br>G2: n = 28 conversion to full-thickness and repair    | - Significant improvement in functional outcomes (ASES, Constant) in both groups without significant differences at final follow-up<br>- No statistical difference in re-tear rates between groups: 96.8% and 96.4% for G1 and G2 respectively   |
| Castagna et al <sup>48</sup>   | 2015 | II                | 74            | Ellman 3A     | G1: n = 37 in situ repair<br>G2: n = 37 conversion to full-thickness and repair    | - Significant improvement in functional outcomes (VAS, Constant) in both groups without significant differences at final follow-up   |
| Shin SJ et al <sup>44</sup>    | 2015 | III               | 84            | Ellman 3B     | G1: n = 47 in situ repair<br>G2: n = 37 conversion to full-thickness and DR repair | - Significant improvement in functional outcomes (ASES, Constant) in both groups without significant differences at final follow-up<br>- No statistical difference in re-tear rates between groups 8.5% and 8.1% for G1 and G2 respectively  |

Note. PTRCTs, partial thickness rotator cuff tears; ASES, American Shoulder and Elbow Surgeons; N, number; G1, group 1; G2, group 2; VAS, visual analogue scale; DR, double-row.

published between 2005 and 2016 describing in situ repair of partial articular supraspinatus tendon avulsions (PAS-TAs).<sup>20</sup> They showed good and excellent results with low complication rates in most studies. It is important to highlight that although the evaluated studies showed good results, the majority were case series with a small number of patients.<sup>20</sup> In 2016, Ranalletta et al evaluated 80 patients with a mean age of 51 years who had undergone arthroscopic in situ repair for painful PARCTs with a minimum of two-year follow-up.<sup>37</sup> The authors found significant functional improvements and pain relief in most patients, with a low rate of complications in the midterm follow-up. Ninety-two per cent of patients were satisfied with their results. Moreover, concurrent procedures performed at the time of supraspinatus repair (biceps tenotomy/tenodesis or subscapular repair) did not change functional outcomes.<sup>37</sup>

Different techniques involving preservation of intact articular-side fibres for partial bursal rotator cuff tears (PBRCTs) have been reported with favourable functional and radiological outcomes.<sup>38–40</sup> Koh et al retrospectively evaluated 38 patients with PBRCTs of the supraspinatus tendon who received an in situ repair on the bursal side for tears greater than 50% thickness.<sup>38</sup> They described satisfactory functional outcomes and an 87.9% healing rate. Kim et al also reported favourable functional outcomes and an 89% healing rate by magnetic resonance arthrography examination after a simple repair of the detached lateral layer in 54 patients with a supraspinatus PBRCT.<sup>39</sup> More recently, Xiao and Cui also reported favourable outcomes

with single repair of the lateral cuff layer in 49 patients with a supraspinatus PBRCT after a minimum two-years follow-up.<sup>40</sup> Eighty-four per cent of patients had a healed tendon and 16% of patients had a partial re-tear. The clinical scores were not significantly different between the two groups.<sup>40</sup> Whether or not acromioplasty is necessary in addition to in situ repair is controversial. The American Academy of Orthopaedic Surgeons did not find strong evidence to favour a routine acromioplasty at the time of rotator cuff repair.<sup>41</sup> Furthermore, two recently published systematic reviews of randomized controlled trials (RCTs) of patients undergoing arthroscopic rotator cuff repair treated with subacromial decompression found no difference from those treated without subacromial decompression.<sup>42,43</sup> Moreover, performing a concomitant acromioplasty did not lead to an improvement in structural healing or re-tear rates.<sup>41,44</sup> In 2017, Ranalletta et al published the results of in situ repair without acromioplasty in 74 patients with PBRCTs with a minimum two-years follow-up.<sup>45</sup> In the midterm follow-up (42 months), arthroscopic in situ repair of PBRCTs without acromioplasty yielded significant functional improvements and pain relief.<sup>45</sup>

*In situ arthroscopic repair of PTRCTs versus repair after conversion to full-thickness tear*

There is a lack of studies directly comparing in situ repair and the complete repair technique (Table 1). In 2012, Shin was the first to compare functional and radiological outcomes in a prospective randomized study between

patients with PARCTs.<sup>46</sup> Of the patients, 24 received arthroscopic in situ repair and 24 received arthroscopic rotator cuff repair after tear completion. The authors found no significant differences between functional and structural outcomes.<sup>46</sup> In 2013, Franceschi et al<sup>47</sup> prospectively compared 32 patients who underwent arthroscopic rotator cuff repair with an in situ technique (group 1) with 28 who underwent arthroscopic full-thickness conversion and repair of the lesion (group 2). The authors found no differences regarding functional outcomes, return to sports, and re-tear rates. At the last follow-up, magnetic resonance imaging showed rotator cuff healing in 31 patients from group 1 and 27 patients from group 2 ( $p = 0.83$ ).<sup>47</sup>

In 2015, Castagna et al<sup>48</sup> prospectively randomized 72 patients into two groups. The first group was treated with arthroscopic in situ repair, whereas the second was treated with an arthroscopic completion of the tear and formal repair. The authors concluded that both techniques provide satisfactory results in terms of function and pain without any significant difference between them.<sup>48</sup>

There is no prospective randomized study comparing different techniques for partial-bursal tears. Shin et al,<sup>44</sup> in a retrospective study, compared 47 patients treated with the modified Mason-Allen single-row repair technique, preserving the articular-sided tendon, and 37 patients treated using the double-row suture-bridge repair technique after conversion to a full-thickness tear. The authors reported no significant differences in functional or structural outcomes between groups. Despite the fact that comparative studies of higher quality of evidence are needed, most of the available literature shows similar results following in situ repair and repair after conversion to full-thickness tear.

The risk of stiffness after repair of partial-thickness rotator cuff tears is a concern. Huberty et al<sup>49</sup> evaluated the incidence of post-operative stiffness following arthroscopic rotator cuff repairs. The authors retrospectively studied 489 patients showing that 4.9% had post-operative stiffness, but that those with PTRCTs had a higher risk at 15%. However, it is not clear in the literature which type of repair is associated with higher risk of stiffness. Jordan et al,<sup>19</sup> in a recent systematic review, evaluated the rate of post-operative stiffness after transtendon repair (TR) or tear completion and repair (TCR) of PTRCTs. The incidence of this complication was reported in only two RCTs and seven case series. Shin<sup>46</sup> demonstrated a trend to a higher incidence after TR (12.5% versus 8.3%) whereas Franceschi et al<sup>46</sup> reported similar rates of stiffness (TR 9.3% versus TCR 10.7%). In addition, the case series suggest a higher rate of stiffness

in the TR group (range 0% to 18% compared to 0% to 2.8% after TCR). Apparently, partial tendon tears are at higher risk of stiffness post-operatively regardless of the surgical technique used to repair them.<sup>20</sup>

#### *In situ repair of PTRCTs: return to sports*

Klouche et al,<sup>50</sup> in a recent systematic review regarding return to sport after rotator cuff tears, evaluated 25 studies including 683 athletes. They reported an overall rate of return to sport of 85%, with 66% returning to an equivalent level of play. Specifically, the rate of return to play in the subgroup of partial-thickness tears was only 60%. There is a lack of large series evaluating return to sports after arthroscopic repair of PARCTs. Rossi et al recently evaluated return to sport, clinical outcomes, and complications in a series of 70 athletes with painful partial-thickness rotator cuff tears treated using arthroscopic in situ repair with a minimum two-year follow-up.<sup>51</sup> Most of the patients were able to return to sports (85%) and at the same level as previous to the injury (78%). The general assessment revealed excellent functional outcomes, with a final American Shoulder and Elbow Surgeons (ASES) score of 88 and a final visual analogue scale (VAS) score of 1.2. The mean delay in return to competition was 5.6 months. Patients who practiced sports with a lower demand for the shoulder (non-collision/non-overhead sports) returned significantly faster to sports than other patients (mean 3.6 months). Moreover, the authors performed a stratified evaluation according to the type of tear (articular versus bursal), age ( $> 40$  or  $< 40$  years), previous level of play (competitive versus recreational) and mechanism of injury (traumatic/atraumatic) and we did not find significant differences in any of the four evaluated variables.<sup>51</sup>

Overhead athletes represent a special subgroup of patients. Although most competitive overhead athletes experience improvement in terms of pain and range of motion after repair of PTRCTs, rates of return to preinjury level of competition have been generally poor.<sup>52-54</sup> Ide et al reported a 33% return to the same or higher level of play in six overhead athletes who underwent in situ repair of PARCTs.<sup>52</sup> Van Kleunen et al examined a series of 17 high-level baseball players with diagnoses of both superior labrum anterior and posterior (SLAP) tear and a significant ( $> 50\%$ ) tear of the infraspinatus tendon who underwent surgical repair of both injuries.<sup>53</sup> Only 35% were able to return to their previous level. Azzam et al recently reported the results of arthroscopic repair of 18 PARCTs in adolescents.<sup>54</sup> Although surgery yielded successful outcomes among adolescents, 57% of the overhead athletes were forced to change positions. Therefore, due to the suboptimal results of rotator cuff repair in

overhead athletes, debridement is generally recommended for these patients when non-operative treatment fails. However, patients should be counselled that rates of return to sports are not optimal with this procedure. Reynolds et al<sup>55</sup> and Payne et al<sup>56</sup> evaluated young overhead athletes who underwent debridement for partial rotator cuff tears and reported only 55% and 45% rates of return to preinjury level of sports respectively. Therefore, efforts should be directed towards improvement with a consistent conservative treatment in this subgroup of athletes.

*In situ repair of PTRCTs: long-term outcomes*

Although in situ repair is proven to be reliable for management of PTRCTs, most clinical outcome studies are limited to short-term follow-up. Rossi et al recently published long-term results of in situ repair of articular and bursal PTRCTs.<sup>57</sup> The authors evaluated 62 patients with a mean follow-up of 10 years (range 8–12 years). There was a significant improvement in functional scores and range of motion. Moreover, 87% of athletes were able to return to their chosen sport and 80% returned to the same level they had achieved before injury. No significant difference regarding functional outcomes or return to sports was found between patients with articular-sided tears and those with bursal-sided tears. No revision surgeries were performed.<sup>57</sup>

**Conclusions**

The available evidence shows that arthroscopic in situ repair of PTRCTs produces excellent functional outcomes in most patients and has a low failure rate. The results are equally favourable for patients with articular or bursal tears and are maintained in the long term. Regarding sports activity, most athletes return to their chosen sport at the same preinjury level with the exception of overhead athletes who should be counselled that return to the same level of competition may be jeopardized with surgery. There are currently not enough clinical data to determine the functional advantages of the repair techniques over each other. Further prospective and comparative studies with large cohort populations and long-term follow-up are necessary to establish with surgical technique is better for the management of PTRCTs.

**AUTHOR INFORMATION**

Hospital Italiano de Buenos Aires, Buenos Aires City, Argentina.

Correspondence should be sent to: Luciano A. Rossi, Peron 4190 (C1199ABB) Buenos Aires- Argentina.

Email: luciano.rossi@hospitalitaliano.org.ar

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**LICENCE**

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