

Review Article

Arthroscopic Rotator Cuff Repair with Single-Row Versus Double-Row Fixation: A Comparative Study

Prochazka O^{1*}, Verhoeven B² and Nicolae R³¹Department of Shoulder and Elbow Surgery, Masaryk University, Brno, Czech Republic²Department of Sports Medicine, KU Leuven, Leuven, Belgium³Department of Physiotherapy and Rehabilitation, Carol Davila University of Medicine and Pharmacy, Bucharest, Romania

*Address for Correspondence: Ondrej Prochazka, Department of Shoulder and Elbow Surgery, Masaryk University, Brno, Czech Republic; E-mail: ondrej.prochazka@masarykuni.cz

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Abstract

Background: Arthroscopic rotator cuff repair can use single-row suture-anchor fixation or double-row/suture-bridge (transosseous-equivalent) constructs, which differ in footprint restoration, biomechanical strength, retear rate, cost, and operative time.

Objective: To synthesise comparative evidence on single-row versus double-row fixation for full-thickness rotator cuff tears.

Methods: Narrative review of cadaveric biomechanical studies, randomized trials, systematic reviews/meta-analyses, and cost-effectiveness analyses comparing the techniques.

Findings: Double-row constructs restore greater footprint contact area and pressure and show superior load-to-failure and cyclic-displacement behaviour. Meta-analyses show no overall retear or functional-score difference for tears under 3 cm, but double-row/suture-bridge fixation reduces retear rates and improves outcomes for tears 3 cm or larger. Double-row repair adds operative time and cost offset only when revision rates fall sufficiently.

Conclusions: Tear size should guide fixation choice: single-row repair remains reasonable for small-to-medium tears, while double-row or suture-bridge fixation is preferred for large and massive tears.

Keywords: Rotator cuff repair; Single-row; Double-row; Suture bridge; Arthroscopy

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Introduction

Arthroscopic repair of full-thickness rotator cuff tears has become the dominant surgical strategy for symptomatic tears that fail non-operative management, but the optimal method of tendon-to-bone fixation remains debated. Single-row repair places one line of suture anchors along the lateral aspect of the greater tuberosity, is technically simpler, faster, and less costly, and was the historical standard [1]. Double-row and suture-bridge (transosseous-equivalent) techniques add a second,

medial row of anchors, or use knotless lateral anchors bridged over the tendon, to increase footprint coverage and construct stability at the expense of implant cost and operative time [1,2]. Since the technique was first biomechanically characterised in the early-to-mid 2000s, a large body of cadaveric, radiographic, and clinical-trial evidence has accumulated comparing the two constructs across tear sizes.

This review synthesises the biomechanical rationale for double-row and suture-bridge fixation, the structural-healing and functional-outcome evidence from randomized trials and meta-analyses, the influence of tear size on the comparative advantage of each technique, and the operative-time and cost implications of adopting a two-row construct. It is a narrative synthesis of the published literature, not a report of the authors' own surgical series.

Biomechanical Rationale

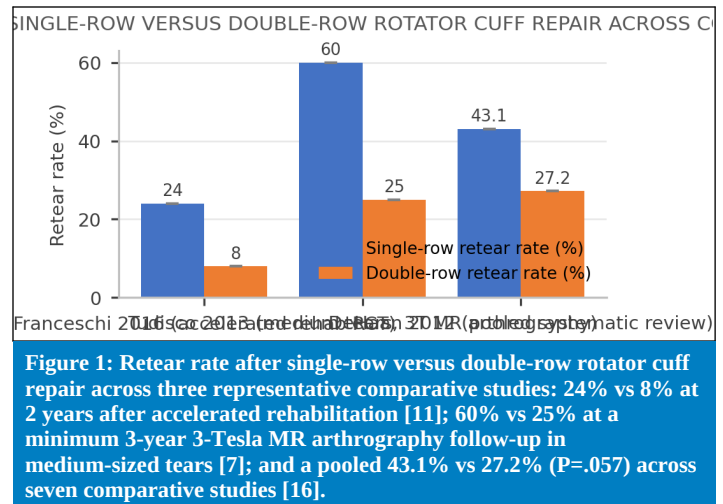
The initial cadaveric comparisons that popularised double-row fixation demonstrated that a medial and lateral anchor configuration restores substantially more of the native tendon footprint than a single line of anchors: Apreleva and colleagues showed the reconstructed contact area with a "mattress+simple" double-anchor configuration approximated the native footprint far more closely than a single-row equivalent [2]. Park and colleagues' paired biomechanical studies quantified this directly, showing markedly greater footprint contact area and mean contact pressure with a transosseous-equivalent suture-bridge construct compared with a traditional double-row repair, itself already superior to single-row fixation in contact restoration (Part I), while Part II demonstrated superior time-zero ultimate load to failure and reduced gap formation under cyclic loading for the transosseous-equivalent construct [3,4]. The original description of the transosseous-equivalent technique

articulated the rationale for compressing the tendon against a broader footprint using bridging lateral sutures rather than knots [1]. Pauly and colleagues' systematic review confirmed double-row repairs consistently show superior initial fixation strength and footprint restoration, though cautioned biomechanical superiority does not automatically translate into superior clinical healing or function [5].

Structural Healing and Retear Rates

Clinical structural-outcome data have been more equivocal than the biomechanical data. Charousset and colleagues' prospective comparative cohort using computed tomographic arthrography found improved tendon healing with double-row fixation, particularly for larger tears, although overall retear rates did not differ significantly by width category alone [6]. Tudisco and colleagues' three-year 3-Tesla MR arthrography comparison of 40 patients with medium-sized tears found a retear rate of 60% after single-row repair versus 25% after double-row repair, yet mean Constant scores were statistically similar (70 versus 68) [7]. Duquin and colleagues' systematic review pooling retear rates across single-row, double-row, and combined constructs found the double-row and suture-bridge groups had significantly lower retear rates than single-row repair for tears larger than 1 cm, but no significant advantage for smaller tears [8]. Hein and colleagues' systematic review of retear rates at a minimum of one year of imaging follow-up similarly found double-row and suture-bridge constructs trended toward lower retear rates than single-row repair, most consistently for larger tears [9]. Mihata and colleagues' comparison of single-row, double-row, and combined double-row/suture-bridge repair found the suture-bridge group had significantly higher structural healing rates than single-row repair on MRI, translating into better American Shoulder and Elbow Surgeons (ASES) scores [10]. Retear rates reported for

single-row versus double-row repair across three representative comparative studies are summarised in Figure 1.



Randomized Controlled Trials

Several adequately powered randomized trials have directly compared the two constructs. Franceschi and colleagues randomized patients to accelerated rehabilitation after single-row or double-row repair and found a significantly lower full-thickness retear rate with double-row fixation (8% versus 24%) at two years, although functional outcomes and stiffness rates did not differ [11]. Carbonel and colleagues' 160-patient randomized trial found double-row repair produced significantly better clinical outcomes for tears exceeding 30 mm, with comparable structural integrity between groups overall [12]. In contrast, Lapner and colleagues' multicentre randomized trial of 90 patients found no significant difference in retear rate or patient-reported outcome between single-row and double-row fixation at two years, prompting continued debate about whether earlier single-centre trials overestimated the double-row advantage [13]. Kim and colleagues found the comparative advantage of double-row suture-bridge fixation depended on preoperative remnant tendon

length, favouring single-row repair when the remnant was short and double-row when it was longer [14]. Wang and colleagues' comparison in massive tears found double-row fixation achieved significantly better Constant and UCLA scores and lower retear rates than single-row repair in this most severe tear category [15]. Design, sample size, and key findings of these and related comparative studies are listed in Table 1.

Table 1: Selected randomized and comparative studies of single-row versus double-row/suture-bridge rotator cuff repair [11,12,13,14,15,7,10].				
Study	Design	N	Tear size focus	Key finding
Franceschi 2016	RCT (accelerated rehabilitation)	60	Mixed	Retear 24% (SR) vs 8% (DR); function similar
Carbonel 2012	RCT	160	Mixed; subgroup >30 mm	DR better clinical outcome for tears >30 mm; structural integrity similar
Lapner 2012	Multicentre RCT	90	Mixed	No significant difference in retear or patient-reported outcome
Kim 2013	RCT	78	Larger than medium	Outcome depends on preoperative remnant tendon length
Mihata 2011	Comparative cohort	Not stated	Mixed	Suture-bridge highest structural healing and ASES scores
Wang 2015	Comparative cohort	Not stated	Massive	DR superior Constant/UCLA scores; lower retear rate
Tudisco 2013	Comparative cohort	40	Medium	Retear 60% (SR) vs 25% (DR); Constant scores similar (70 vs 68)

Meta-Analyses and the Effect of Tear Size

Multiple meta-analyses pooling these trials converge on a tear-size-dependent conclusion. DeHaan and colleagues' systematic review of seven comparative studies found no difference in ASES, Constant, or UCLA scores between

techniques overall, but a non-significant trend toward lower retear rates with double-row repair (27.2% versus 43.1%, P=.057) [16]. Zhang and colleagues' meta-analysis of eight prospective studies found double-row repair produced superior functional scores and structural integrity specifically for tears exceeding 3 cm, with no significant difference for smaller tears [17]. Perser and colleagues' meta-analysis of clinical and radiographic outcomes reached a similar overall conclusion of comparable function with a structural-healing advantage for double-row constructs [18]. Sheibani-Rad and colleagues' meta-analysis restricted to randomized trials found no significant difference in retear rate or clinical outcome scores between single-row and double-row repair when all tear sizes were pooled together [19]. Chen and colleagues' meta-analysis similarly found comparable ASES and Constant scores between techniques but a significantly lower overall retear rate with double-row fixation [20]. Mascarenhas and colleagues' systematic review of overlapping meta-analyses concluded that double-row repair offers a structural-healing advantage, most apparent in larger tears, without a consistent difference in patient-reported functional outcome [21]. Millett and colleagues' meta-analysis restricted to level I randomized trials likewise found no significant difference in ASES or Constant scores but a trend toward improved structural integrity with double-row fixation [22]. Sobhy and colleagues explicitly tested whether structural integrity and function correlate, finding that while double-row repair reduced retear rates, the correlation between healed structural integrity and superior functional scores was inconsistent across studies, suggesting factors beyond fixation construct influence patient-reported outcome [23]. The most tear-size-stratified analysis, by Gu and colleagues, pooled outcomes specifically by tear width and found no significant retear-rate difference for tears under 3 cm but a significantly lower retear rate with double-row repair for

tears 3 cm or larger [24]. Table 2 summarises these meta-analyses alongside the cost-effectiveness literature discussed below.

Table 2: Meta-analyses stratified by tear size and cost-effectiveness analyses of single-row versus double-row/suture-bridge rotator cuff repair [16,17,24,19,25,27].		
Study	Type	Key stratified or economic finding
DeHaan 2012	Systematic review, 7 studies	No PRO difference; retear trend 43.1% (SR) vs 27.2% (DR), P=.057
Zhang 2013	Meta-analysis, 8 studies	DR superior for tears >3 cm; no difference <3 cm
Gu 2023	Meta-analysis stratified by tear width	No retear difference <3 cm; DR significantly lower retear >=3 cm
Sheibani-Rad 2013	Meta-analysis, RCTs only	No significant difference pooling all tear sizes
Genuario 2012	Cost-effectiveness analysis	DR not cost-effective under base-case retear assumptions
Huang 2017	Cost-effectiveness analysis (updated inputs)	DR more cost-effective via avoided revisions in larger tears

Operative Time and Cost

Double-row and suture-bridge constructs require additional anchors, suture management, and arthroscopic time, raising per-case implant and operating-room cost relative to single-row repair. Genuario and colleagues' cost-effectiveness analysis modelled the incremental cost per quality-adjusted life-year of double-row over single-row repair and found double-row fixation was not cost-effective at accepted willingness-to-pay thresholds under base-case retear-rate assumptions, though the result was sensitive to the assumed retear-rate differential [25]. Bisson and colleagues' cost analysis estimated that shifting the United States rotator cuff repair market fully to double-row or suture-bridge constructs would raise annual expenditure by 80 to 262 million dollars, and calculated that cost-neutrality would require avoiding one revision surgery for every four to seventeen primary repairs, a reduction they considered unlikely to be

achieved uniformly across tear sizes [26]. More recently, using updated retear-rate and quality-of-life inputs reflecting the tear-size-stratified benefit of double-row fixation in larger tears, Huang and colleagues' cost-effectiveness analysis concluded double-row repair was in fact more cost-effective than single-row repair, driven primarily by avoided revision surgery costs in larger tears [27]. Together these analyses indicate that the economic case for double-row fixation, like the clinical case, depends heavily on tear size and the retear-rate differential assumed; the projected market-level cost impact of switching techniques is illustrated in Figure 2.

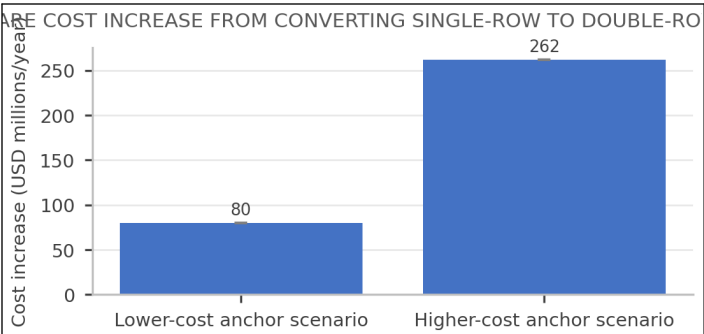


Figure 2: Projected annual increase in United States healthcare expenditure from converting single-row rotator cuff repair practice fully to double-row/suture-bridge fixation, under lower- and higher-cost anchor scenarios [26].

Discussion

Taken together, the biomechanical, structural-healing, and cost literature converge on a tear-size-dependent recommendation rather than a uniform preference for either construct, echoing the broader principle that fixation-construct decisions in rotator cuff surgery should be individualised rather than protocolised. Footprint contact area, contact pressure, and time-zero mechanical strength are consistently superior with double-row and suture-bridge fixation in cadaveric models [2,3,4], and this biomechanical advantage translates into a measurable reduction in retear rate for larger tears in most clinical series and meta-analyses [17,24,15,9]. For tears smaller than approximately 3 cm, however, single-row repair

achieves comparable structural healing and equivalent functional scores at lower cost and shorter operative time, and the added expense of double-row fixation is difficult to justify economically in this subgroup [16,19,26]. Remnant tendon length, tissue quality, and surgeon experience also modulate which construct performs better in an individual patient, complicating a single blanket recommendation [14]. Randomized trials have produced somewhat inconsistent results, with some finding clear double-row superiority in retear rate [11,12] and at least one large multicentre trial finding no difference [13], likely reflecting heterogeneity in tear size distribution, suture configuration, and rehabilitation protocol across trials. Correlation between structural healing and functional outcome is also imperfect, meaning a lower retear rate does not automatically guarantee a proportionally better patient-reported result [23]. Limitations include variable retear definitions across imaging modalities, heterogeneous configurations grouped together as "double-row," and limited long-term follow-up in most trials.

Conclusion

Double-row and suture-bridge (transosseous-equivalent) fixation restores greater tendon footprint contact and provides superior time-zero biomechanical strength compared with single-row repair, and this advantage is reflected clinically as a lower retear rate and better functional outcome specifically in tears 3 cm or larger [24,17,15]. For smaller and medium-sized tears, single-row repair achieves comparable structural and functional outcomes at lower cost and shorter operative time [16,26,25]. Fixation technique should therefore be selected according to tear size, tissue quality, and remnant tendon length rather than applied uniformly, and future comparative trials should stratify by tear size and report both structural and economic outcomes to refine this decision further.

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