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Review article

Superior capsular reconstruction – A systematic review and meta-analysis

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ABSTRACT

Background: Since Mihata's 2012 proposal to arthroscopically reconstruct the superior capsule of patients with massive irreparable cuff tears, many studies have reported the clinical results of this technique using different types of grafts (fascia lata autograft, dermal allograft, porcine dermal xenograft or long head of biceps autograft).
Purpose: The objective of this meta-analysis was to report the clinical and radiological results of these superior capsule reconstructions.
Methods: Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) recommendations were used to conduct this systematic review. A bibliographic search was performed of the electronic databases MEDLINE, Scopus, Embase and the Cochrane Library. The quality of the studies was assessed according to the MINORS criterion (Methodological Index for Nonrandomized Studies). The inclusion criteria were studies in English evaluating superior capsular reconstruction.
Results: No level I or II studies met the inclusion criteria. Eighteen studies were selected from the 97 identified, including 637 shoulders (64% male) with a mean age of 62 years [95% CI: 60.3–63.5]. At the mean follow-up of 24.3 months (12–60), the range of motion was significantly increased from 82.6° [60.0–105.2] to 141.9° [109.9–173.8] in abduction, from 113.1° [98.3–127.9] to 153.3° [147.4–159.2] in elevation, from 35.5° [30.9–40.2] 43.4° [35.4–51.3] in external rotation and from 7.2 [5.4–9] to 9.9 [8.9–10.9] in internal rotation. Functional scores were significantly improved from 5.4 [4.8–5.9] to 1.3 [0.9–1.7] points for VAS, from 42.5 [15.7–69.3] to 59.3 [30.1–88.6] points for Constant, from 39.0% [38.1–39.8] to 79.8% [76.4–83.3] for the SSV, and from 48.2 [45.2–51.1] to 81.2 [77.2–85.1] points for the ASES. The healing rate was 76.1% [64.4–84.9]. The complication rate was 5.6% [1.8–16.3] and the reverse shoulder arthroplasty revision rate was 7.1% [3.8–12.8].
Conclusion: Superior capsule reconstructions allow satisfactory clinical and radiological results to be obtained at 2 years of follow-up. Due to the small number of high quality comparative studies available, its true place in the therapeutic arsenal cannot be fully confirmed. However, it seems that the best indication for this technique is isolated irreparable rupture of the supraspinatus, in cases of medical treatment failure.
Level of evidence: III; meta-analysis of heterogeneous studies.

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1. Introduction

Massive irreparable rotator cuff tears can lead to various clinical presentations depending on the number of tendons involved, the muscles affected and the presence or absence of prior cuff repair surgery [1,2]. Thus, depending on these different parameters, shoulder can present as; painless and fully functional but lacking strength, or functional and painful, or non-functional in the horizontal and vertical planes [2,3].

The management of these injuries depends on these different clinical presentations, the quality of the muscles and tendons and the age of the patient. Tendon transfers have proven their effectiveness in horizontal imbalances [4–6] and the reverse shoulder arthroplasty remains the preferred treatment in vertical imbalances (pseudoparalytic shoulder) [7]. However, the treatment of mobile, functional, painful shoulders (irreparable rupture of the supraspinatus with or without infraspinatus involvement [1]) remains highly controversial, particularly when the tendon of the long head of biceps is no longer present [8] or when the subject is too young to be a candidate for a reverse shoulder arthroplasty.

Massive irreparable posterosuperior tears are associated with a defect of the superior glenohumeral capsule, which is located on the deep surface of the tendons of the supra- and infra-spinatus. It has been demonstrated that this superior capsule plays a stabilizing role in the glenohumeral joint, particularly by preventing superior translation of the humeral head. In 2012, Mihata et al. proposed [9] arthroscopic reconstruction of the superior capsule in patients suffering from massive irreparable ruptures of the supra- and infra-spinatus using a fascia lata autograft to restore glenohumeral stability. Since then, numerous articles have reported the clinical results of this technique using different types of grafts (fascia lata autograft, dermal allograft, porcine dermis xenograft or long head of biceps autograft). These vary greatly in terms of functional results, graft healing on imaging, and particularly, indications, thus making it difficult to ascertain the true place of this technique amongst the therapeutic arsenal.

The objective of this meta-analysis was to report the clinical and radiological results of superior capsular reconstructions.

2. Materials and methods

We conducted a systematic review according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) [10] recommendations.

2.1. Research strategy

We considered all clinical studies evaluating the results of arthroscopic superior capsule reconstruction. We included all studies regardless of level of evidence (1 to 4), in English, without restrictions on publication status (published, unpublished, in press). The databases searched were: MEDLINE via PubMed, The Cochrane Central Register of Controlled Trials (CENTRAL 2018, number 10), EMBASE, Scopus/Science Citation Index/Emerging Source citation index/CINAH. We used the following search terms: shoulder, glenohumeral, superior capsular reconstruction, rotator cuff rupture, irreparable and massive. A specific algorithm was used for each database and previous systematic reviews were examined. The research was done in November 2020.

2.2. Selection of studies

We removed duplicates [11]. Systematic reviews, case reports or biomechanical studies were excluded, as well as studies with less than 1 year of follow-up. The relevant studies were selected by 3 authors (JDW, CC, BS), working independently and resolving the differences by reaching a consensus (Tables 1 and 2). When 2 published studies focused on the same population, the most recent was used. Excluded studies, and reasons for exclusion were listed.

2.3. Assessment of the quality of studies

The quality of the studies was assessed using the MINORS (Methodological Index for Non-Randomized Studies) score [29], considering the following criteria: objective defined or not, inclusion of consecutive patients, prospective data collection, unbiased assessment of endpoints, follow-up period appropriate to endpoint, loss of follow-up less than 5%, prospective calculation of study size, adequate control group, equivalence of inclusion groups and appropriate statistical analysis (Table 3). This evaluation was carried out by two authors, in liaison, to ensure that a consensus was reached in the event of disagreement.

2.4. Data extraction

Data were extracted using a standardized form by 2 authors (JDW, CC). The data included: date of publication, patient demographics (age, sex), clinical data (revision, complications, healing, clinical results, functional score), thickness and type of graft.

2.5. Statistical analysis

Data were analyzed using R software®. Clinical outcomes (abduction, anterior elevation, external rotation, internal rotation) and patient-reported functional scores (Constant, SSV, ASES, VAS) were calculated with 95% confidence intervals. Revisions, complications and healing rates were also evaluated with 95% confidence intervals (95% CI). The I^2 statistic was used to measure the heterogeneity of the results. As the expected heterogeneity rate was high, a random effects model was used. A test was performed to assess the difference between preoperative and postoperative data. Subgroup analyzes were performed to evaluate the different amplitudes and scores, depending on the type of graft (xenograft allograft or autograft).

3. Results

3.1. Study characteristics

In total, we selected 18 studies [12–28,30] among the 97 identified (Fig. 1) This included a total of 637 shoulders (385 men and 221 women) with a mean age of 61.9 years (95% CI: [60.3; 63.5]). In these studies, published between 2013 and 2020, the mean follow-up was 24.3 months (range; 12–60 months). Seven studies reported results of dermal autografts with a median thickness of 3 mm [minimum-maximum: 2–3], 2 of dermal xenografts (thickness of 1.5 mm and 3 mm), 5 of fascia lata autografts (median thickness of 6 mm [4.6–6.5]), 2 fascia lata autografts with mesh reinforcement (thickness of 7.2 and 7.6 mm), one long head of biceps autograft and one of porcine xenograft of 4 mm. Most were primary surgeries, however some followed previous surgical failures. Surgery of the biceps was not systematically mentioned, nor its preoperative status.

The taxonomy of ruptures was described by either the Cofield score [31], using an anteroposterior and mediolateral measurement of the size of the rupture, or by the type of tendon affected, thus making comparisons between studies difficult. These ruptures involved 2 to 3 anterosuperior, posterosuperior, or more than 5 cm tendons, depending on the Cofield score.

Table 1
Description of preoperative studies.

Study	Patients	Age	Type of graft	Thickness	Follow-up	Anterior elevation	Abduction	External rotation	Internal rotation	ASES	VAS	Constant	SSV	AHD
Denard [12] (2018)	59	62 (8.7)	Dermal allograft	2	17.7	130 (48)		36 (18)	8	43.6 (18.6)	5.8 (2.3)		35 (19.9)	6.6 (3)
Lee [13] (2018)	36	60.9 (6.2)	Fascia Lata Autograft		24.8 (6.9)	105.8 (41.2)		40.8 (16.9)	10 (4.4)	50.3 (9.1)	5.8 (1.2)	56.3 (9)		5 (2.1)
Pennington [14] (2018)	88	59.4 (27–79)	dermal allograft	3	22	121 (10–180)	103 (15–180)			52.22 (19.29)	4.03 (2.55)			7.1
Lim [15] (2019)	31	65.3 (44–85)	Fascia Lata autograft	6	15	133 (35)		28 (16)		54.4 (17.9)	6 (1.2)	51.7 (13.9)		5.3 (2.2)
Mihata [16] (2019)	30	68 (52–78)	Fascia Lata autograft	4.6	60	85 (54)		27 (20)	7 (5–11)	29 (20)	6.9 (2.2)			3.4 (2.2)
Polacek [17] (2019)	20	60 (45–72)	Dermal xenograft	1.5	12	68.6 (21.4)	65.4 (21.1)							7
Woodmass [18] (2019)	34	60 (48–7)	Dermal allograft	3	12 (6–23)	95	72	33			4.9		26.6	
Burkhart [19] (2020)	41	64 (1.4)	Dermal allograft	3	34 (24–50)	140 (120–159)		37 (29–44)		52 (3)	4.6 (3.8–5.4)		39 (33–44)	7 (0.4)
Barth [20] (2020)	24	60 (7)	Long head of biceps autograft		25	143 (33)		49 (16)	4 (2–11)	45 (19)	5.2 (2)	50 (13)	41 (12)	
Azevedo [21] (2020)	21	64.8 (8.84)	Fascia Lata autograft	6.5	24	77.63	54.47	13.95	4			18.84	35.53	6.24 (3.33)
Ferrando [22] (2020)	56	65 (9)	Dermal xenograft	3	24 (8)					41 (19)	6.5 (2.1)		39 (17)	5.43 (2)
Kholinne [23] (2020)	34	64.9 (8.7)	Fascia Lata autograft	6	31.3 (8.2)	103 (20)		26 (16)		54.4 (17.2)	6 (1.1)			4 (0.7)
Kholinne [23] (2020)	30	65.1 (6.1)	Fascia Lata auto-graft + Mesh	7.2	24.1 (4.6)	109 (22)		27 (17)		48.1 (13.2)	5.7 (1)			4.8 (1.5)
Lacheta [24] (2020)	22	56 (41–65)	Dermal allograft	3	25.2 (24–36)	136		41		54 (17–90)	4 (0–8)			7 (5-14)
Pashuck [25] (2020)	14	58.9 (11)	Dermal allograft	3	25.2 (22.8)	128 (36)				55 (17)	3.3 (2)			6 (2)
Polacek [26] (2020)	23	61.25 (41–76)	Fascia Lata auto-graft + Mesh	7.6	12	67 (22.3)	59.5 (21.9)							
Gilat [27] (2021)	54	56.3 (5.8)	Dermal allograft		24	136.2 (40–180)	101.9 (45–180)	47.1 (15–70)	8 (5–15)	45.8 (18.3)		12.2 (6.9)		5.4 (2.3)
Greiner [28] (2021)	20	62.1 (47–77)	Porcine xenograft	4	25.7 (24–30)							49.7		7.1 (2.1)

Table 2
Description of postoperative studies.

Study	Complications	Revisions	Healing	External rotation	Internal rotation	ASES	VAS	Constant	SSV	AHD
Denard [12] (2018)	4	11	26	45 (17)	10	77.5 (22)	1.7 (2.1)		76.3 (25.2)	6.7 (3)
Lee [13] (2018)			23			84		82.8		8.9
Pennington [14] (2018)	0	1	84			81.56 (10.21)	1.51 (1.21)			
Lim [15] (2019)			22	30 (15)		73.7 (10.8)	2.5 (1.2)	63.7 (8.1)		6.4 (2.3)
Mihata [16] (2019)	1	0	27	41 (20)	9 (5–13)	92.3 (10.3)	0.9 (1.7)			8.1 (3.2)
Polacek [17] (2019)	6	5								
Woodmass [18] (2019)		8		36			5		45.8	
Burkhart [19] (2020)	0	3	22	59 (51–67)		89 (2)	0.7 (0.4–1)		83 (79–87)	8 (0.4)
Barth [20] (2020)			22	50 (16)	11 (5–16)	80 (15)	1.4 (1.4)	77 (10)	75 (18)	
Azevedo [21] (2020)	5	0	18	38.68	7			69.63	71.58	
Ferrando [22] (2020)		4		44 (10)		90 (9)	0.2 (0.4)		80 (11)	
Kholinne [23] (2020)			20	32 (13)		73.7 (13.8)	2.9 (0.8)			6.3 (1.8)
Kholinne [23] (2020)			25	39 (13)		77.4 (12)	1.8 (0.6)			9.1 (2.4)
Lacheta [24] (2020)		1	16	35		83.9 (41.6–98.3)	0 (0–3)			8.3 (2)
Pashuck [25] (2020)	2	1	9			86.5 (9)	0.6 (1)			6.7 (2)
Polacek [26] (2020)	2	4								
Gilat [27] (2021)		3		49.7 (20–90)	10 (5–16)	65.6 (20.6)		19.6 (9.9)		
Greiner [28] (2021)		1						77.1 (10.5)		7.8 (2.7)

Table 3
Evaluation of the studies selected according to the MINORS criteria.

	Clearly expressed objective	Consecutive patients included	Prospective data collection	Primary endpoint in agreement with objective	Unbiased assessment of outcomes	Duration of follow-up appropriate to the objective of the study	Less than 5% lost to follow-up	Prospective calculation of the cohort	Adequate control group	Contemporary groups	Comparable groups	Adequate statistical analysis	Total
Denard [12] (2018)	2	0	0	2	2	1	1	0	N/A	N/A	N/A	1	9
Lee [13] (2018)	2	0	0	2	2	0	0	2	N/A	N/A	N/A	1	9
Pennington [14] (2018)	2	2	0	2	0	1	0	0	N/A	N/A	N/A	0	7
Lim [15] (2019)	2	0	0	2	2	0	0	0	N/A	N/A	N/A	2	8
Mihata [16] (2019)	2	0	0	2	1	1	0	0	N/A	N/A	N/A	2	8
Polacek [17] (2019)	2	2	0	2	2	2	2	0	N/A	N/A	N/A	1	13
Woodmass [18] (2019)	2	0	0	2	2	0	0	0	N/A	N/A	N/A	1	7
Burkhart [19] (2020)	2	0	0	2	2	2	1	0	N/A	N/A	N/A	1	10
Barth [20] (2020)	2	2	0	2	2	2	0	0	2	2	1	2	17
Azevedo [21] (2020)	2	2	2	2	2	2	1	2	N/A	N/A	N/A	2	17
Ferrando [22] (2020)	2	2	0	2	2	2	1	0	0	2	0	2	15
Kholinne [23] (2020)	2	0	0	2	2	2	1	2	2	2	2	1	18
Lacheta [24] (2020)	2	2	0	2	2	2	2	2	N/A	N/A	N/A	1	15
Paschuck [25] (2020)	2	1	2	2	2	2	0	0	N/A	N/A	N/A	2	13
Polacek [26] (2020)	2	2	0	2	2	2	2	0	N/A	N/A	N/A	1	13
Gilat [27] (2021)	2	0	0	2	2	1	0	0	N/A	N/A	N/A	1	8
Greiner [28] (2021)	2	2	0	2	2	2	2	2	2	2	1	2	21

0: not reported; 1: reported but inadequate; 2: reported and adequate.

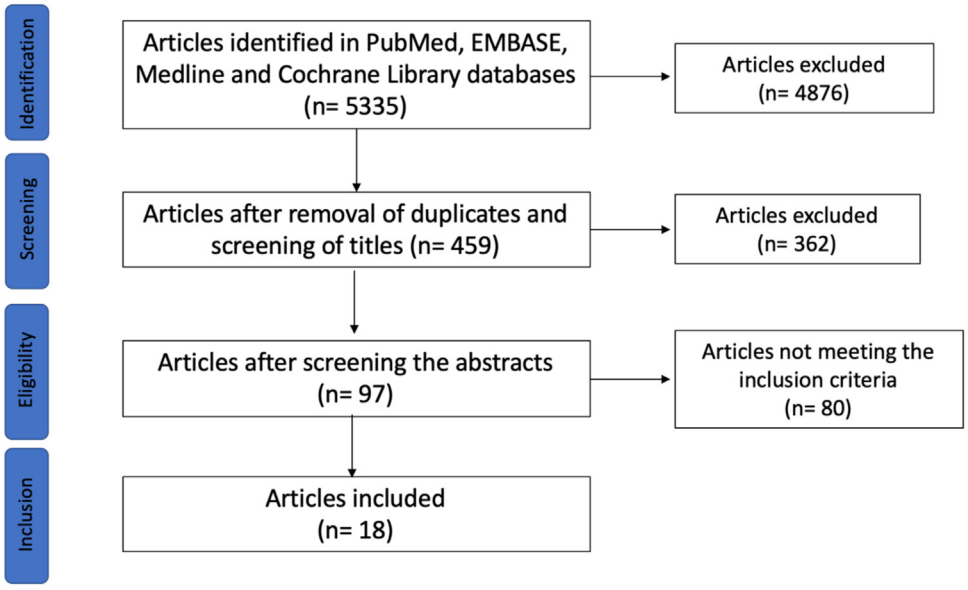

Fig. 1. Patient inclusion flowchart.

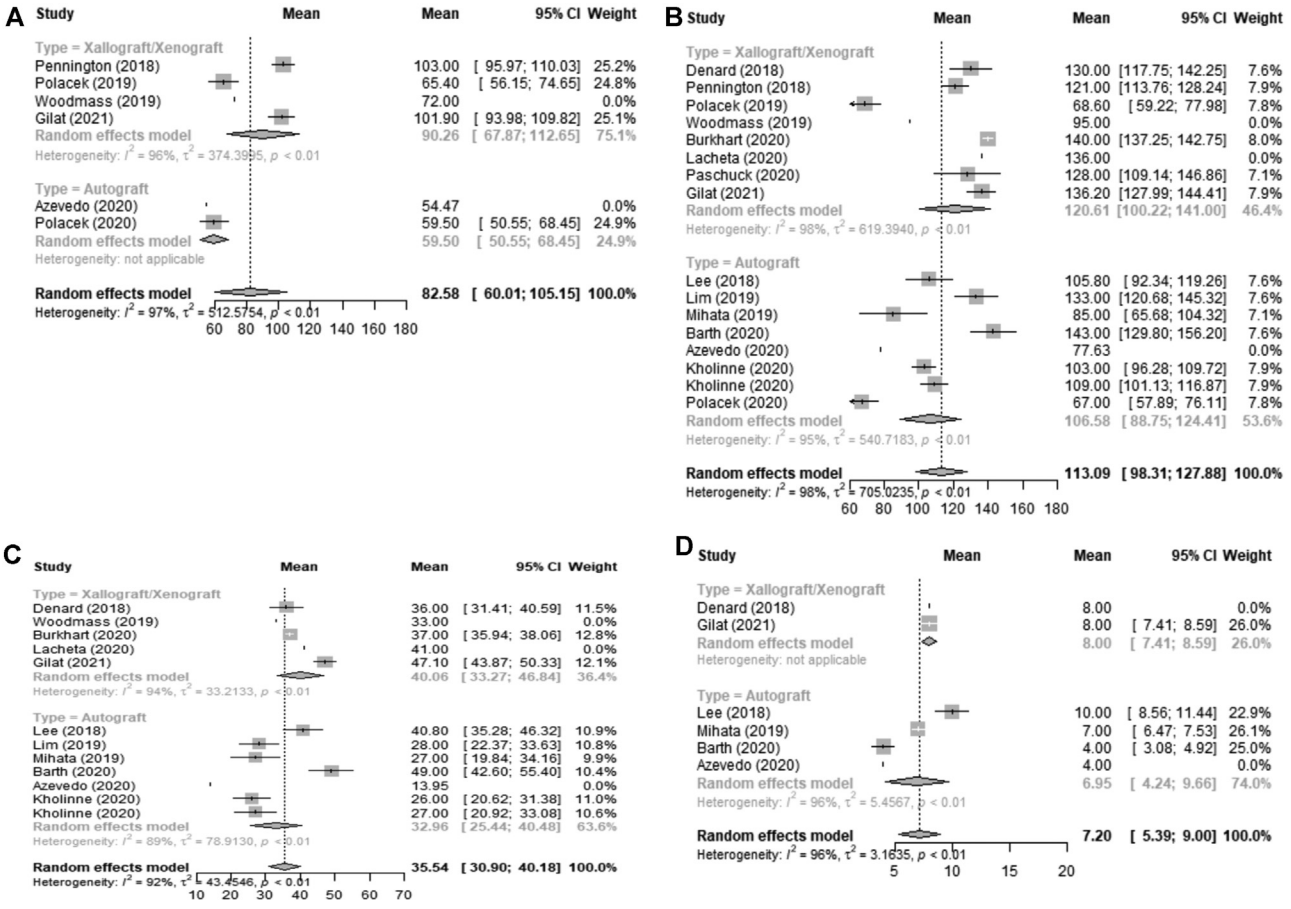

Fig. 2. Forest plot of average preoperative mobility: A: abduction; B: elevation; C: external rotation; D: internal rotation.

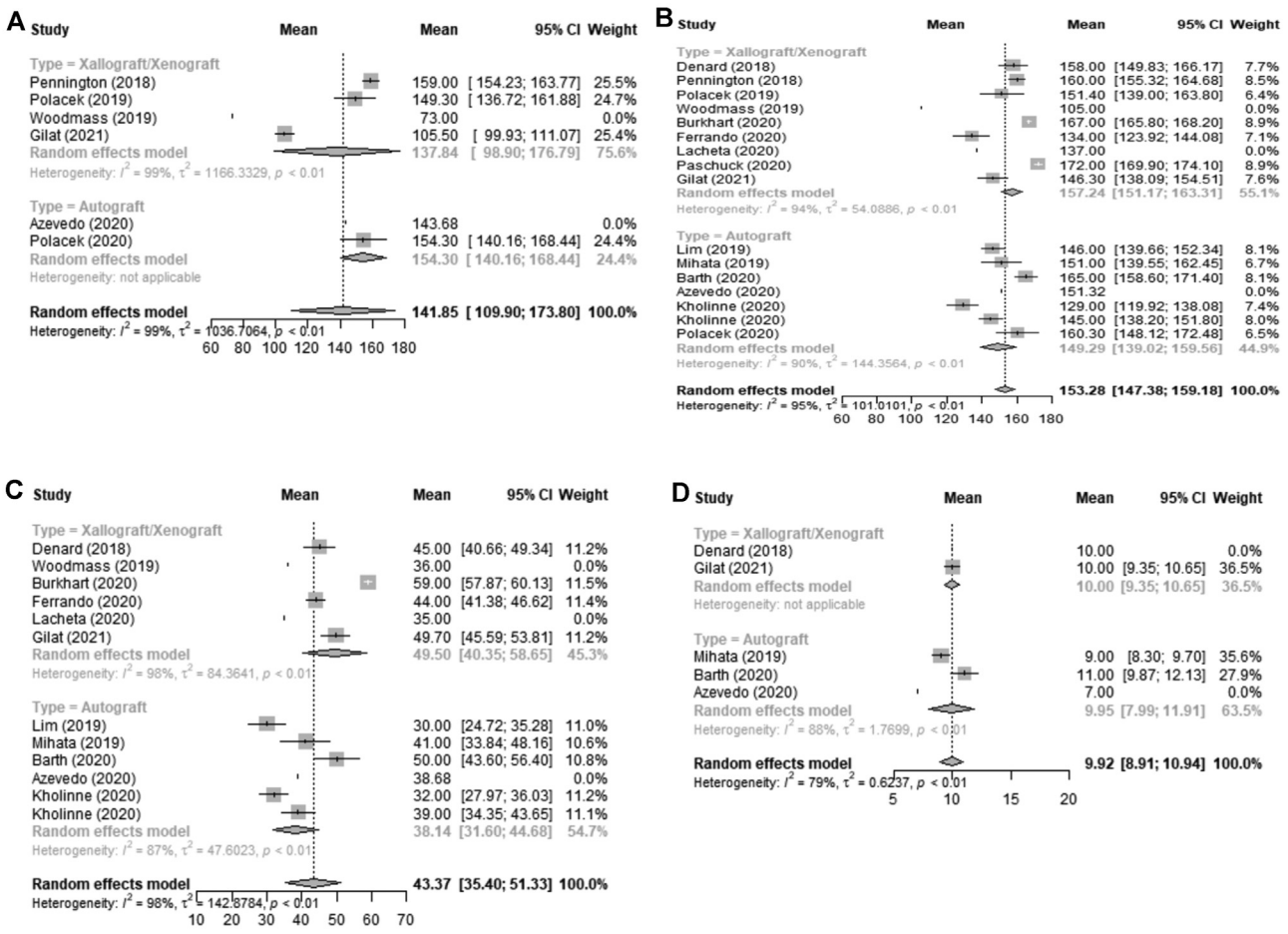

Fig. 3. Forest plot of the mean postoperative mobility: A: abduction; B: elevation; C: external rotation; D: internal rotation.

3.2. Clinical results

The combined results of the preoperative amplitudes gave an abduction of 82.6° [60.0–105.2], an anterior elevation of 113.1° [98.3–127.9], an external rotation of 35.5° [30.9–40.2] and an internal rotation of 7.2 points [5.4–9]. (Fig. 2). Postoperative amplitude assessments showed improvements in abduction at 141.9° [109.9–173.8], $p = 0.003$), in anterior elevation at 153.3° [147.4–159.2], $p < 0.0001$), in external rotation 43.4° ([35.4–51.3], p = 0.03) and internal rotation at 9.9 points [8.9–10.9], $p = 0.007$). (Fig. 3).

The combined results of the preoperative functional scores gave a VAS of 5.4 points [4.8–5.9], an ASES score of 48.2 points [45.2–51.1], a Constant score of 42.5 points [15.7–69.3] and an SSV of 39.0% [38.1–39.8]. (Fig. 4). The evaluations of the postoperative functional scores showed an improvement in the ASES score (81.2 points [77.2–85.1], $p < 0.0001$), the Constant score (59.3 points [30.1–88.6], $p = 0.006$) and the SSV (79.8% [76.4–83.3], $p < 0.0001$) and a decrease in VAS (1.3 points [0.9–1.7], $p < 0.0001$). (Fig. 5).

3.3. Imaging results

The combined preoperative measurement of acromiohumeral distance was 5.6 mm [4.7–6.5] with a significant increase postoperatively ($p < 0.0001$). (Fig. 6).

The healing rate was 76.1% [64.4–84.9] This was evaluated by a postoperative MRI in most studies.

The complication rate was 5.6% [1.8–16.3]. The most frequently reported complications were surgical site infections, persistent biceps pain, anchor pullouts, donor site complications, and an acute immune rejection response in a xenograft case.

The reverse shoulder arthroplasty revision rate represented 7.1% [3.8–12.8]. (Fig. 7).

3.4. Sub-group analysis

We observed a difference in abduction between autografts and xenografts preoperatively; 59.5° [50.6–68.5] vs. 98.3° [67.9–112.9], $p = 0.01$) and no significant difference for the anterior elevation ($p = 0.3$), external rotation ($p = 0.2$) and internal rotation ($p = 0.5$). (Fig. 2). Postoperatively, there was no significant difference (Fig. 3). There was no significant difference in postoperative functional scores. (Fig. 4). However, the combined measures of postoperative VAS were superior in the autograft group (1.9 points [1.3–2.6] vs. 0.8 points [0.4–1.1], $p = 0.002$). (Fig. 5).

4. Discussion

Our meta-analysis shows that according to the 18 studies selected, superior capsular reconstruction provides good clinical results with improved range of motion and reduced pain, without the risk of major complications. The analysis of these different studies also makes it possible to retain relatively consistent indications for superior capsule reconstruction. Thus, we can retain that superior capsular reconstruction is indicated in irreparable supraspinatus ruptures, without osteoarthritis (Hamada < 4), without irreparable rupture of the associated subscapularis. However, in these different studies, we find a great heterogeneity of techniques,

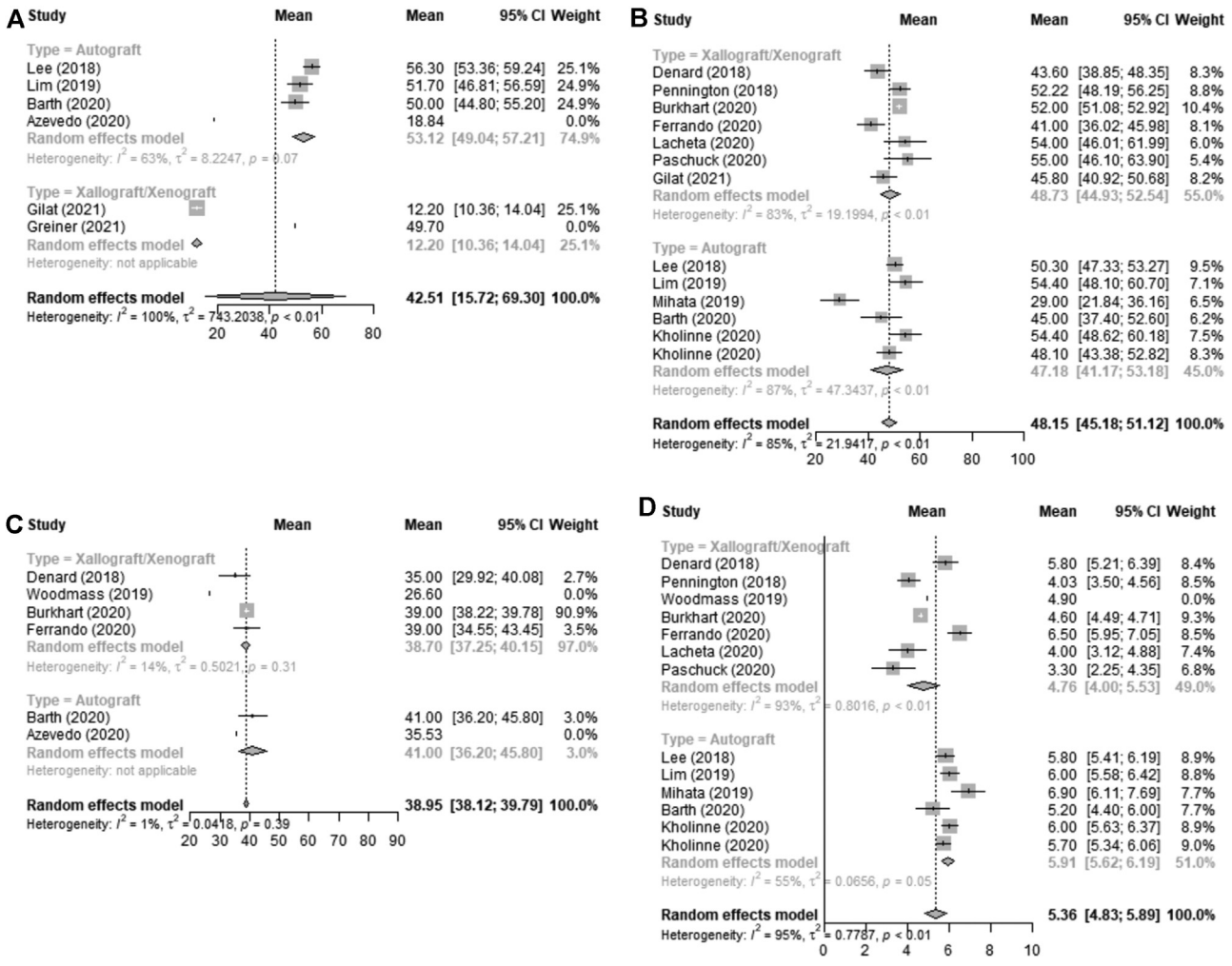

Fig. 4. Forest plot of the mean preoperative functional scores: A: constant; B: ASES; C: SSV; D: VAS.

implants and above all a lack of a clear definition of the number of affected tendons, as well as of the preoperative fatty infiltration of the various muscles. When this is clearly analyzed, it seems that when the infraspinatus is also irreparable, the superior capsule repair does not allow a satisfactory functional result to be obtained, regardless of the type of implant proposed. Indeed, Denard et al. [12] reported 25.4% of clinical failures and a graft healing rate on MRI of only 45% in their series which included 65% of patients with Goutallier stage 3 fatty infiltration of the infraspinatus. Likewise, Woodmass et al. [18] found 65% of clinical failures in their series which included 21.9% of patients with stage 3 or 4 fatty infiltration of the infraspinatus. Thus, they showed that fatty infiltration of the infraspinatus ≥ stage 2 was associated with a significant increase in the risk of failure and/or revision surgery.

In addition, our study clearly shows the absence of high level evidence studies evaluating the results of superior capsule reconstructions with only 3 being level III evidence studies (17%), and the remainder being level IV studies.

It is well established that the size of cuff tears is associated with functional outcome [32] and some studies have reported re-tear rates of up to 78% in massive cuff tears. Despite these disappointing results, repair attempts remain first-line [33,34]. However, this is not always possible in cases of excessive tendon retraction [35], insufficient tendon length or excessive fatty infiltration. In these cases of irreparable ruptures, many treatment options have been proposed. These include: non-operative treatment by rehabilitation and steroid injections, isolated tenotomy of the long head of biceps [8], partial repair [36], biodegradable subacromial spacer use [37], superior capsular reconstruction [9], tendon transfers [4,5] and reverse shoulder arthroplasty [7]. The true place of these different treatments in the therapeutic arsenal, as well as their precise indications remain unknown [38].

A stricter radioclinical classification would undoubtedly allow a comparison of the patients treated and the results of the different therapeutic proposals. The preoperative assessment of the status of teres minor on MRI is never mentioned in the various studies, although its atrophy, rupture or hypertrophy is a determining factor in the tolerance of these massive ruptures [39].

In our opinion, the radiological assessment should include:

- a standard X-ray with measurement of the acromiohumeral distance and an evaluation of osteoarthritis according to the Hamada classification;
- a MRI to determine the affected tendons and classification according to the Collin classification [1], and an evaluation of fatty infiltration according to the Goutallier classification [40].

The clinical evaluation should systematically assess the preoperative stiffness because it was not clearly described in these different studies. In addition, a more standardized clinical evaluation would make it possible to analyze the active amplitude deficit both in elevation and in external rotation, defining the various possible clinical pictures and thus be able to compare the results of the different techniques. The loss of active external rotation in

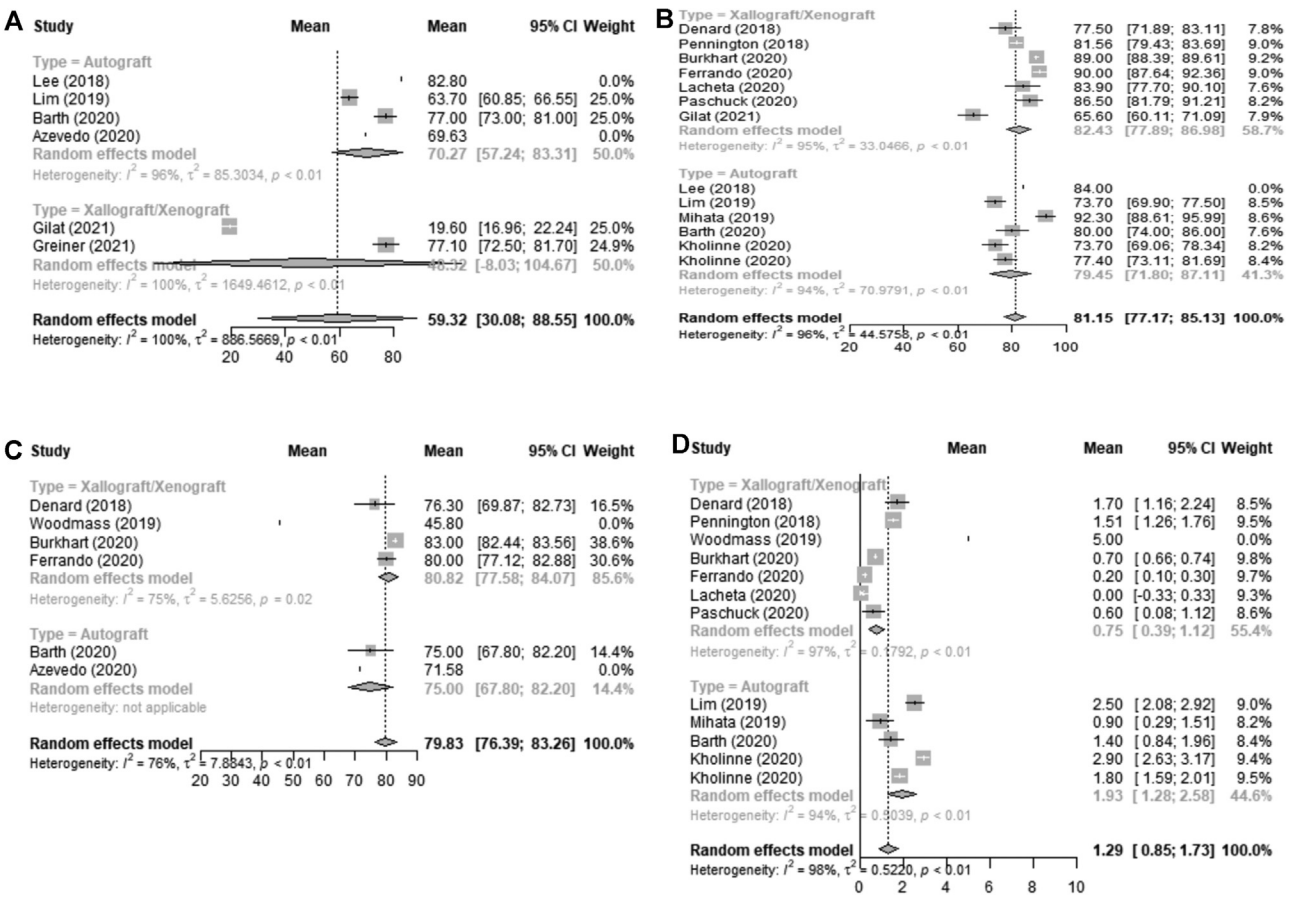

Fig. 5. Forest plot of the mean postoperative functional scores: A: constant; B: ASES; C: SSV; D: VAS.

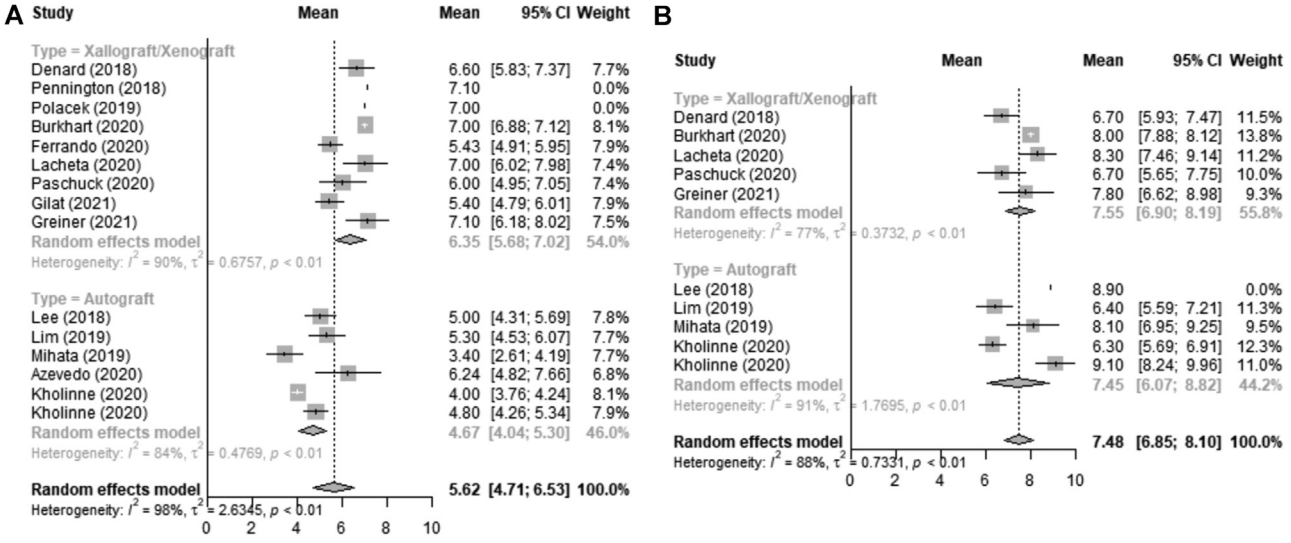

Fig. 6. Forest plot of the mean acromiohumeral distance: A: preoperatively; B: postoperatively.

elevation or elbow to the body is a discriminating element in the preoperative evaluation which is poorly understood by the generic scores. Using a score to define combined tables of loss of amplitude would certainly exclude some patients at high risk of capsular repair failure. Boileau's Isolated Loss of Active Elevation (ILAE), Isolated Loss of active External Rotation (ILER) and Combined Loss of active Elevation and External Rotation (CLEER) classification is a possible solution regardless of the resulting therapeutic solutions [2].

This meta-analysis has a number of limitations. Firstly, the main limitation is the lack of studies with a high level of evidence. Subsequently, the heterogeneity of the types of implants used on small series does not allow conclusions to be made regarding the differences between these various grafts, even if one can logically imagine that a 6.5 mm thick fascia lata autograft does not have the same biomechanical and biological structural properties as a 1.5 mm thick porcine dermal xenograft or even the tendon of the long head of biceps, remaining normally inserted on the

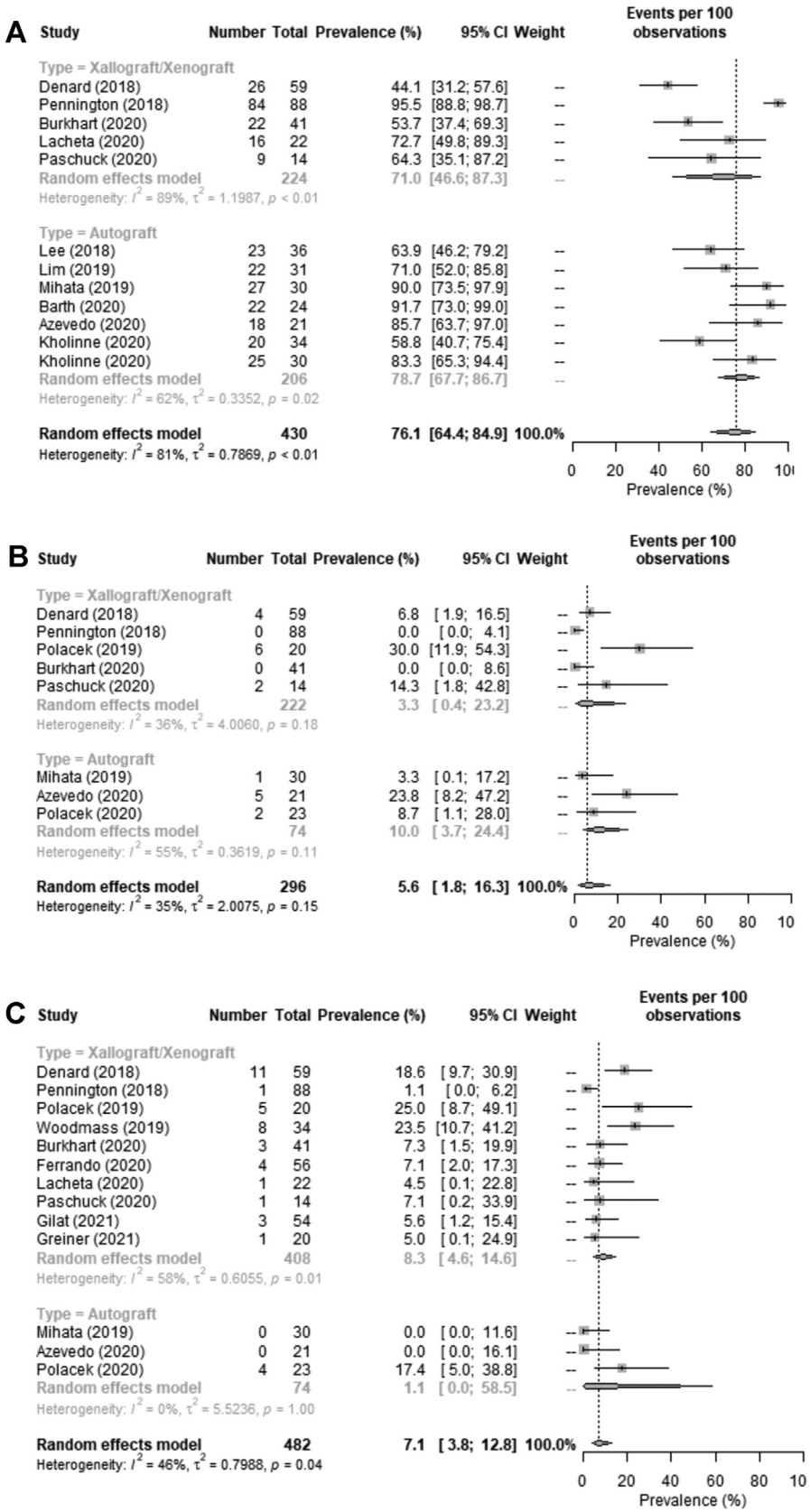

Fig. 7. Forest plot of the overall rate of: A: healing; B: complications; C: revisions.

supraglenoid tubercle. Finally, the large variety of patients included in the different studies makes it difficult to define a clear indication for this surgical technique.

5. Conclusion

Superior capsule reconstructions allow satisfactory clinical and radiological results to be obtained after 2 years of follow-up. The small amount of comparative studies with a high level of evidence does not allow us to conclude on the place for this surgical technique amongst the therapeutic arsenal. However, it seems that the best indication for this technique is isolated irreparable rupture of the supraspinatus in cases of failed medical treatment.

Disclosure of interest

Dr. Lädermann reports personal fees from Stryker, Medacta, Arthrex, outside the submitted work; he is foundation FORE President, BeeMed founder and Follow Health Share owner.

Dr. Schoch is a paid consultant and receives royalties from Exactech.

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The other authors declare that they have no competing interest.

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Contribution

Dr. Werthel: conceptualization, methodology, writing – original draft.

M. Vigan: formal analysis, methodology, writing – original draft.

Dr. Schoch: methodology, data curation.

Dr. Lädermann: supervision, writing – review & editing.

Dr. Nourissat: supervision, writing – review & editing.

Dr. Conso: validation, methodology, writing – original draft.

References

[1] Collin P, Matsumura N, Ladermann A, Denard PJ, Walch G. Relationship between massive chronic rotator cuff tear pattern and loss of active shoulder range of motion. J Shoulder Elbow Surg 2014;23:1195–202.
[2] Boileau P, McClelland Jr WB, Rumian AP. Massive irreparable rotator cuff tears: how to rebalance the cuff-deficient shoulder. Instr Course Lect 2014;63:71–83.
[3] Kany J, Anis H, Werthel JD. Massive irreparable rotator cuff tears. Obere Extremität 2018;13:246–54.
[4] Gerber C, Vinh TS, Hertel R, Hess CW. Latissimus dorsi transfer for the treatment of massive tears of the rotator cuff. A preliminary report. Clin Orthop Relat Res 1988;232:51–61.
[5] Elhassan BT, Wagner ER, Werthel JD. Outcome of lower trapezius transfer to reconstruct massive irreparable posterior-superior rotator cuff tear. J Shoulder Elbow Surg 2016;25:1346–53.
[6] Valenti P, Werthel JD. Lower trapezius transfer with semitendinosus tendon augmentation: indication, technique, results. Obere Extrem 2018;13:261–8.
[7] Mulieri P, Dunning P, Klein S, Pupello D, Frankle M. Reverse shoulder arthroplasty for the treatment of irreparable rotator cuff tear without glenohumeral arthritis. J Bone Joint Surg 2010;92:2544–56.
[8] Walch G, Edwards TB, Boulahia A, Nove-Josserand L, Neyton L, Szabo I. Arthroscopic tenotomy of the long head of the biceps in the treatment of rotator cuff tears: clinical and radiographic results of 307 cases. J Shoulder Elbow Surg 2005;14:238–46.
[9] Mihata T, McGarry MH, Pirolo JM, Kinoshita M, Lee TQ. Superior capsule reconstruction to restore superior stability in irreparable rotator cuff tears: a biomechanical cadaveric study. Am J Sports Med 2012;40:2248–55.
[10] Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.
[11] Bramer WM, Giustini D, de Jonge GB, Holland L, Bekhuis T. De-duplication of database search results for systematic reviews in EndNote. J Med Libr Assoc 2016;104:240–3.
[12] Denard PJ, Brady PC, Adams CR, Tokish JM, Burkhart SS. Preliminary results of arthroscopic superior capsule reconstruction with dermal allograft. Arthroscopy 2018;34:93–9.
[13] Lee SJ, Min YK. Can inadequate acromiohumeral distance improvement and poor posterior remnant tissue be the predictive factors of re-tear? Preliminary outcomes of arthroscopic superior capsular reconstruction. Knee Surg Sports Traumatol Arthrosc 2018;26:2205–13.
[14] Pennington WT, Bartz BA, Pauli JM, Walker CE, Schmidt W. Arthroscopic superior capsular reconstruction with acellular dermal allograft for the treatment of massive irreparable rotator cuff tears: short-term clinical outcomes and the radiographic parameter of superior capsular distance. Arthroscopy 2018;34:1764–73.
[15] Lim S, AlRamadhan H, Kwak JM, Hong H, Jeon IH. Graft tears after arthroscopic superior capsule reconstruction (ASCR): pattern of failure and its correlation with clinical outcome. Arch Orthop Trauma Surg 2019;139:231–9.
[16] Mihata T, Lee TQ, Hasegawa A, Fukunishi K, Kawakami T, Fujisawa Y, et al. Five-year follow-up of arthroscopic superior capsule reconstruction for irreparable rotator cuff tears. J Bone Joint Surg Am 2019;101:1921–30.
[17] Polacek M. Arthroscopic superior capsular reconstruction with acellular porcine dermal xenograft for the treatment of massive irreparable rotator cuff tears. Arthrosc Sports Med Rehabil 2019;1:e75–84.
[18] Woodmass JM, Wagner ER, Borque KA, Chang MJ, Welp KM, Warner JJP. Superior capsule reconstruction using dermal allograft: early outcomes and survival. J Shoulder Elbow Surg 2019;28:S100–9.
[19] Burkhart SS, Pranckun JJ, Hartzler RU. Superior capsular reconstruction for the operatively irreparable rotator cuff tear: clinical outcomes are maintained 2 years after surgery. Arthroscopy 2020;36:373–80.
[20] Barth J, Olmos MI, Swan J, Barthelemy R, Delsol P, Boutsiadis A. Superior capsular reconstruction with the long head of the biceps autograft prevents infraspinatus retear in massive posterosuperior retracted rotator cuff tears. Am J Sports Med 2020;48:1430–8.
[21] Azevedo CIC, Catarina Leiria Pires Gago Angelo A, Campos-Correia D, Delgado L, Ferreira N, Sevivas N. Clinical importance of graft integrity in arthroscopic superior capsular reconstruction using a minimally invasively harvested midthigh fascia lata autograft: 3-year clinical and magnetic resonance imaging outcomes. Am J Sports Med 2020;48:2115–28.
[22] Ferrando A, Kingston R, Delaney RA. Superior capsular reconstruction using a porcine dermal xenograft for irreparable rotator cuff tears: outcomes at minimum two-year follow-up. J Shoulder Elbow Surg 2021;30:1053–9.
[23] Kholinne E, Kwak JM, Kim H, Koh KH, Jeon IH. Arthroscopic superior capsular reconstruction with mesh augmentation for the treatment of irreparable rotator cuff tears: a comparative study of surgical outcomes. Am J Sports Med 2020;48:3328–38.
[24] Lacheta L, Horan MP, Schairer WW, Goldenberg BT, Dornan GJ, Pogorzelski J, et al. Clinical and imaging outcomes after arthroscopic superior capsule reconstruction with human dermal allograft for irreparable posterosuperior rotator cuff tears: a minimum 2-year follow-up. Arthroscopy 2020;36:1011–9.
[25] Pashuck TD, Hirahara AM, Cook JL, Cook CR, Andersen WJ, Smith MJ. Superior capsular reconstruction using dermal allograft is a safe and effective treatment for massive irreparable rotator cuff tears: 2-year clinical outcomes. Arthroscopy 2021;37:489e1–96e1.
[26] Polacek M, Nyegaard CP. Superior capsular reconstruction using 3-layered fascia lata autograft reinforced with a nonresorbable suture mesh. Arthrosc Sports Med Rehabil 2020;2:e489–97.
[27] Gilat R, Haunschild ED, Williams BT, Fu MC, Garrigues GE, Romeo AA, et al. Patient factors associated with clinical failure following arthroscopic superior capsular reconstruction. Arthroscopy 2021;37:460–7.
[28] Greiner S, Kaeaeb M, Voss A, Lawton R, Bhide P, Achenbach L. Comparison of superior capsular reconstruction and partial infraspinatus repair: a matched-pair analysis of irreparable rotator cuff tears. Orthop J Sports Med 2021;9 [2325967120984264].
[29] Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (minors): development and validation of a new instrument. ANZ J Surg 2003;73:712–6.
[30] Mihata T, Lee TQ, Fukunishi K, Itami Y, Fujisawa Y, Kawakami T, et al. Return to sports and physical work after arthroscopic superior capsule reconstruction among patients with irreparable rotator cuff tears. Am J Sports Med 2018;46:1077–83.
[31] Cofield RH. Subscapular muscle transposition for repair of chronic rotator cuff tears. Surg Gynecol Obstet 1982;154:667–72.
[32] Rashid MS, Cooper C, Cook J, Cooper D, Dakin SG, Snelling S, et al. Increasing age and tear size reduce rotator cuff repair healing rate at 1 year. Acta Orthop 2017;88:606–11.
[33] Konig MA, Braunstein VA. Tendon repair leads to better long-term clinical outcome than debridement in massive rotator cuff tears. Open Orthop J 2017;11:546–53.
[34] Burkhart SS, Barth JR, Richards DP, Zlatkin MB, Larsen M. Arthroscopic repair of massive rotator cuff tears with stage 3 and 4 fatty degeneration. Arthroscopy 2007;23:347–54.
[35] Kovacevic D, Suriani Jr RJ, Grawe BM, Yian EH, Gilotra MN, Hasan SA, et al. Management of irreparable massive rotator cuff tears: a systematic review and meta-analysis of patient-reported outcomes, reoperation rates, and treatment response. J Shoulder Elbow Surg 2020;29:2459–75.
[36] Burkhart SS. Partial repair of massive rotator cuff tears: the evolution of a concept. Orthop Clin North Am 1997;28:125–32.

[37] Deranlot J, Herisson O, Nourissat G, Zbili D, Werthel JD, Vigan M, et al. Arthroscopic subacromial spacer implantation in patients with massive irreparable rotator cuff tears: clinical and radiographic results of 39 retrospectives cases. Arthroscopy 2017;33:1639–44.
[38] Jordan RW, Sharma N, Daggett M, Saithna A. The role of superior capsule reconstruction in the irreparable rotator cuff tear – A systematic review. Orthop Traumatol Surg Res 2019;105:1535–42.
[39] Kikukawa K, Ide J, Terakawa Y, Takada K, Morita M, Hashimoto K, et al. Hypertrophic teres minor restores shoulder strength and range of external rotation in posterosuperior rotator cuff tears. J Shoulder Elbow Surg 2016;25:1882–8.
[40] Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Relat Res 1994;304:78–83.