Does graft thickness affect outcomes in massive rotator cuff repairs with graft augmentation? A systematic review and meta-analysis

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Aims & Objective

- Surgical repair of massive rotator cuff tears remains challenging, particularly in terms of healing. Currently there is no universal consensus regarding the best thickness of graft for repair.
- This study aims to appraise and determine whether graft thickness influences functional outcomes and re-tear rates in massive rotator cuff repairs (RCRs) with graft augmentation, and to compare effectiveness of on-lay versus bridging/interposition techniques.

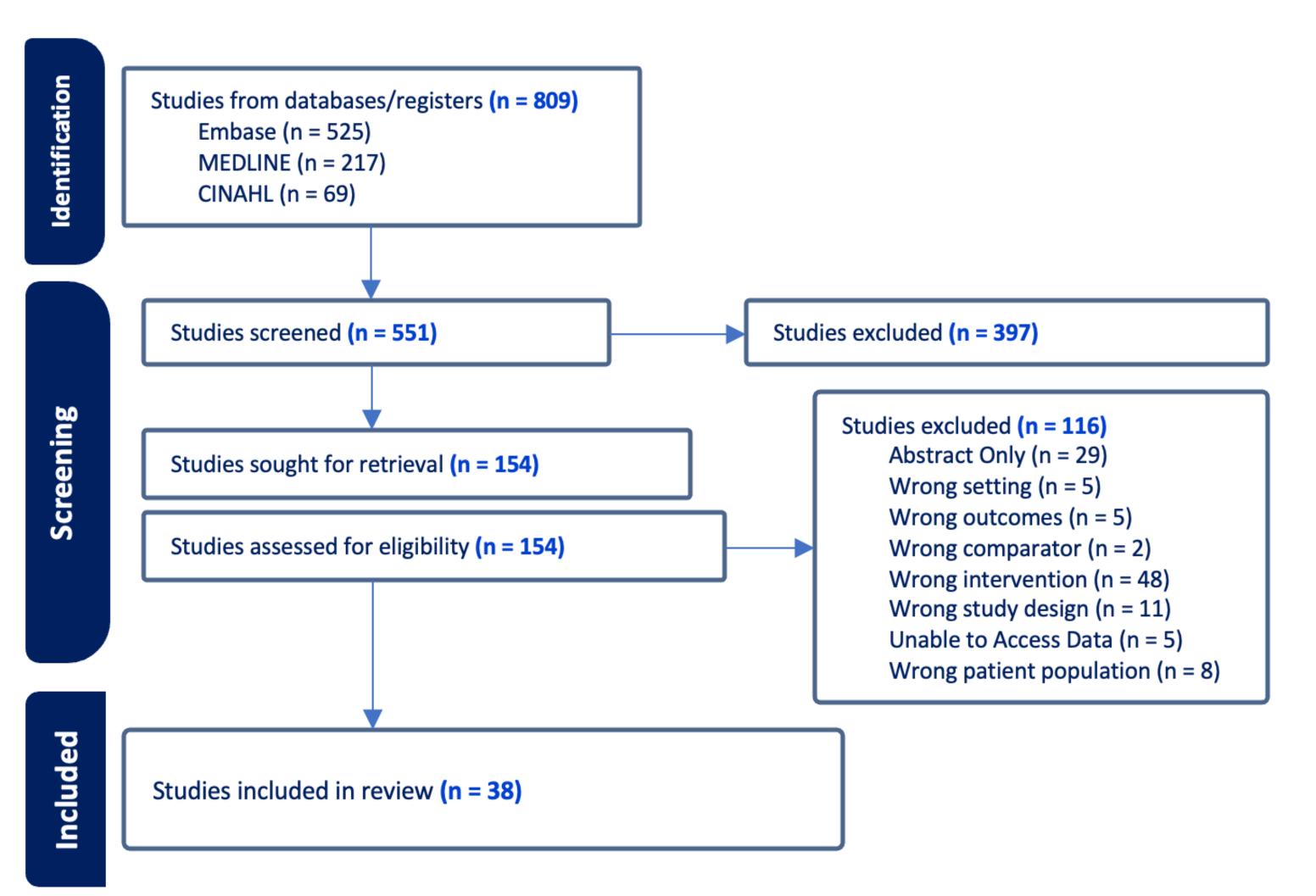


Figure - PRISMA flowchart for comprehensive data search

Methods

- A systematic review was performed in accordance with the PRISMA guidelines where databases were comprehensively searched between **April 2006** and **April 2025**. (Figure-1).
- Clinical studies reporting shoulder-specific functional outcomes scores and retear rates evaluating RCRs with graft augmentation (on-lay or bridging) using allografts, xenografts and synthetic grafts, as well as comparative studies with standard repair with minimum 12-months follow-up were included.
- Studies were stratified by graft thickness (≤2mm vs >2mm) and technique (onlay vs bridging).
- Meta-analysis was conducted using a random-effects models if ≥2 comparative studies reported the same outcome measure using Rev-Man Web. Outcomes used for analysis included PROMs- Constant Murley Score(CMS) and radiographic re-tear rates with at least a mean FU period of 12 months.
- A proportional meta-analysis was conducted for single arm studies using R-Studio. Risk of bias assessment was undertaken for randomised and comparative studies (ROBINS- I, Cochrane).

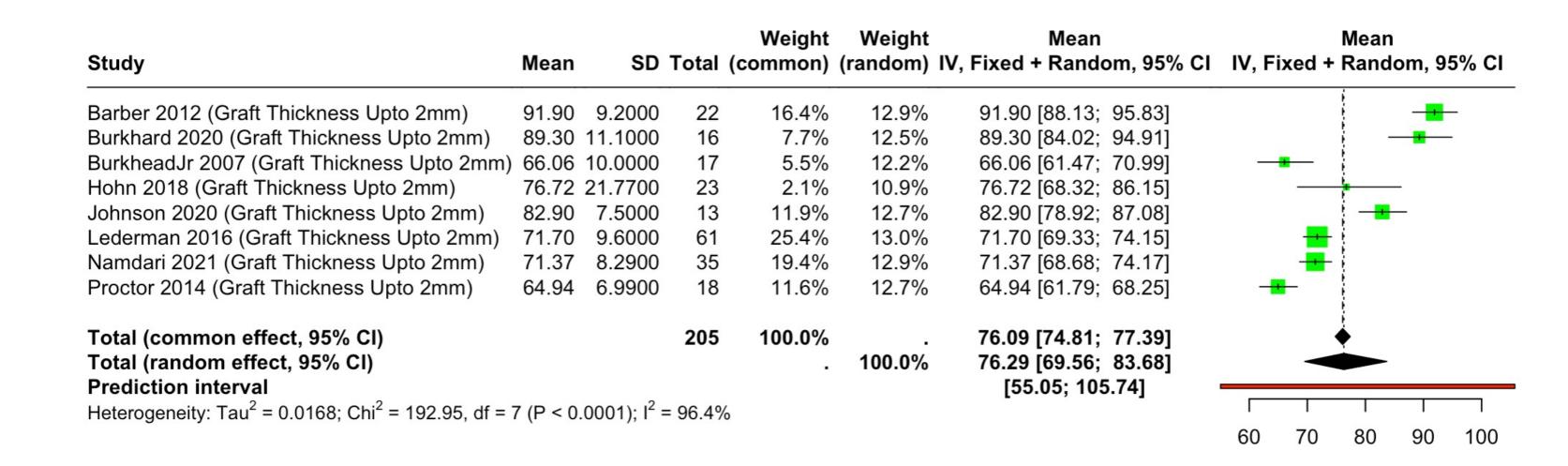
	Graft Augmentation			Control Group			Mean difference		Mean difference	Risk of Bias				
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI	ABCDEFG				
Barber 2012	91.9	9.2	22	85.3	11	20	29.4%	6.60 [0.43 , 12.77]						
Wong 2021	84.23	19.27	15	65.68	23.31	15	16.0%	18.55 [3.24 , 33.86]		• • • ? ? • • ?				
Kim 2023	60.2	11.3	19	62.8	17.6	12	21.4%	-2.60 [-13.78 , 8.58]		• ? • • • ? ?				
Kantanavar 2024	74.82	9.24	36	59.64	8.58	131	33.2%	15.18 [11.82 , 18.54]		+ ? + + + ?				
Total (Waldª)			92			178	100.0%	9.39 [1.09 , 17.68]						
95% prediction interval								[-6.89 , 25.66]	-	•				
Test for overall effect: Z	z = 2.22 (P	= 0.03)							-20 -10 0 10 20	-				
Test for subgroup differ	ences: No	t applicat	ole					Favours [Graft A		ndard Renairl				

	Graft A	Graft Augmentation			Control Group			Mean difference	Mean difference	Risk of Bias				
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI	ABCDEFG				
Gilot 2015	79.75	3.64	20	67.25	8.93	15	18.3%	12.50 [7.71 , 17.29]		? • • ? • • •				
Flury 2018	24.9	11	20	27.5	16.5	20	11.8%	-2.60 [-11.29 , 6.09]		● ● • ? • • •				
Lee 2022	71.1	7.7	22	66.8	14	21	14.7%	4.30 [-2.50 , 11.10]	 -	• • • • • • ?				
Choi 2022	83.2	6.3	17	82.7	9.6	17	17.1%	0.50 [-4.96 , 5.96]		+++++?				
Snow 2023	72.46	13.29	20	68.98	18.98	20	9.9%	3.48 [-6.67, 13.63]	- •	• ? • ? • • ?				
Kang 2025	66	17	27	66	16	28	11.7%	0.00 [-8.73 , 8.73]		• ? • • • ?				
Merolla 2025	84.8	9.1	22	77.3	10	20	16.4%	7.50 [1.70 , 13.30]	_ 	• ? • ? • • ?				
Total (Waldª)			148			141	100.0%	4.28 [0.09 , 8.46]						
95% prediction interval	I							[-5.22 , 13.77]						

Heterogeneity: Tau² (REML^b, 95% CI) = 18.92 [1.42, 115.16]; Chi² = 16.99, df = 6 (P = 0.009); I² = 62%

Favours [Graft Augmentation]

Favours [Standard Repair



	•							
Study or Subgroup	Events	Total	Events	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI	ABCDEF
Barber 2012	3	22	9	20	21.6%	0.19 [0.04 , 0.87]		++++
Kantanavar 2024	2	36	38	131	21.9%	0.14 [0.03 , 0.63]		+ + ? ? + +
Karpyshyn 2025a	3	14	13	15	17.3%	0.04 [0.01, 0.30]		+ + + ?
Kim 2023	8	19	5	12	22.0%	1.02 [0.24 , 4.41]		● ? ● ● ?
Wong 2021	3	15	13	15	17.3%	0.04 [0.01 , 0.27]		+ + ? ? + +
Total (Waldª)		106	;	193	100.0%	0.15 [0.05 , 0.49]		
95% prediction interval						[0.01 , 1.56]		
Total events:	19		78					
Test for overall effect: Z	z = 3.16 (P =	0.002)				(0.005 0.1 1 10 2	_
Test for subgroup differ	ences: Not a	pplicable		Fa	vours [Gra	aft Augmentation- Thickn		andard Repair]
Hotorogopoity: Tou2 /DI	EMI 6 05% C	1) - 1 06 [000 14 03	81· Chi² =	0 08 df =	4 (P = 0.04); $I^2 = 60\%$		

Risk of Bias

Odds ratio

Study	Brid Events	ging Total		dard Total	Risk Ratio	RR	95%-CI Weight
Flury 2018	4	20	9	20		0.44	[0.16; 1.21] 23.9%
Snow 2023	4	20	5	20	: •	0.80	[0.25; 2.55] 17.9%
Kantanavar 2024	2	36	38	131 -		0.19	[0.05; 0.76] 12.8%
Wong 2021	3	15	13	15		0.23	[0.08; 0.65] 22.5%
Karpyshyn 2025a	3	14	13	15	-	0.25	[0.09; 0.69] 22.9%
Random effects model Heterogeneity: $I^2 = 1.3\%$,		105	.3987	201		0.33	[0.20; 0.55] 100.0%
					0.1 0.5 1 2 1	0	

Results

Graft Augmentation

- 38 studies reporting on 1761 total cases (23 studies having graft thickness up to 2mm, 15 studies using > 2mm thickness) were included.
- On-lay augmentation using grafts ≤ 2 mm had better CMS compared to standard repair (MD +9.39 points; 95% CI: 1.09–17.68; p = 0.03; l² = 80%) while grafts>2 mm showed only borderline improvement (MD +4.28 points; 95% CI: 0.09–8.46; p = 0.05; l² = 62%).
- In single-arm analyses, bridging with grafts ≤2 mm achieved the highest mean Constant score (76.29 points; 95% CI: 69.56–83.68), followed by on-lay ≤2 mm grafts (74.64 points; 95% CI: 70.85–78.63).
- On-lay grafts ≤ 2 mm provided the greatest protective effect, yielding an 85% reduction in re-tear risk (OR 0.15; 95% CI: 0.05–0.49; p = 0.04) and the lowest absolute failure rate (8%).
- Bridging with ≤2 mm grafts achieved a 67% risk reduction (RR 0.33; 95% CI: 0.20– 0.55; $I^2 = 1.3\%$), whereas grafts >2 mm reduced risk by 55% (RR 0.45; 95% CI: 0.27– 0.74; $I^2 = 0\%$).
- Pooled proportional analysis demonstrated an overall re-tear rate of 12% (95% CI: 9–15%; $I^2 = 77.9\%$)

	Graft Augm	entation	Control Group			Risk ratio	Risk ratio		Risk of Bias					
Study or Subgroup	Events	Total	Events	Total	Weight	IV, Random, 95% CI	IV, Random, 95%	CI A	В	С	E	F	G	
Gilot 2015	2	20	4	15	10.6%	0.38 [0.08 , 1.78]		?	•	+ ?	•	•	•	
Flury 2018	4	20	9	20	25.6%	0.44 [0.16 , 1.21]	-	•		• ?	•	•	•	
Lee 2022	2	22	8	21	12.6%	0.24 [0.06 , 1.00]	-	•			•	•	?	
Choi 2022	1	17	6	17	6.4%	0.17 [0.02 , 1.24]	-	•	•	+ +	•	•	?	
Snow 2023	4	20	5	20	19.1%	0.80 [0.25 , 2.55]		•	? (• ?	•	•	?	
Kang 2025	4	27	9	28	23.2%	0.46 [0.16 , 1.32]	-	•	? (•	•	•	?	
Merolla 2025	1	22	0	20	2.6%	2.74 [0.12 , 63.63]	-		?	• ?			?	
Total (Wald ^a)		148		141	100.0%	0.45 [0.27 , 0.74]	•							
95% prediction interval						[0.27, 0.74]	_							
Total events:	18		41											
Test for overall effect: 2	Z = 3.10 (P = 0.00)	0.002)					0.01 0.1 1	10 100						
Test for subgroup differ	rences: Not a	pplicable			Favours	[Graft Augmentation- T		ours [Standard	Repai	r]				
Heterogeneity: Tau ² (R	EML ^b , 95% C	(I) = 0.00 [0	.00 , 2.32]	; Chi² = 3	.96, df = 6	$6 (P = 0.68); I^2 = 0\%$	_	_						

Conclusion

- Bridging with thin grafts (≤2 mm) resulted in superior functional outcomes, while onlay augmentation with thin grafts provided enhanced structural integrity, with a retear rate of 8% and an 85% relative risk reduction.
- Both augmentation strategies significantly decrease re-tear incidences compared with standard repair alone, with thin grafts demonstrating consistently greater efficacy across all functional and structural outcome parameters than thick grafts.