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Knotted or knotless double-row rotator cuff repair retear rates: a systematic review and meta-analysis

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Background: Arthroscopic rotator cuff tear repair techniques used to rely on knot-tying double row techniques, but the advent of knotless transosseous equivalent procedures introduced a new variable to the debate. The purpose of this study is to determine which technique is associated with lower retear rates. For its' biomechanical advantages, the authors' hypothesis is that knotless techniques would have lower retear rates.

Methods: A systematic literature search was performed via PubMed and Google Scholar by two independent reviewers following PRISMA guidelines. Papers reporting retear rates after rotator cuff arthroscopic repair using knotted double-row or knotless transosseous equivalent techniques, evaluated by magnetic resonance imaging at least 6 months after surgery, were retrieved. Studies that do not differentiate between techniques and nonclinical reports were excluded. Eligible data was analyzed with Review Manager 5.4.1 using Mantel-Haenszel statistics with a fixed effect model.

Results: The authors' initial literature search retrieved 511 reports. After the selection process, 24 articles were available for this review, and 9 were eligible for meta-analysis. A comparison of 1888 subjects from noncomparative reports and a meta-analysis of reports in which both techniques were studied could not show a statistically significant difference in technique retear rates.

Discussion and conclusion: The current report revealed no significant difference in retear rates between the two arthroscopic repair techniques. Studies' quality was a limitation. Only two reported level 1 evidence. This review could not control variables such as cuff tear size, tissue quality, or individual comorbidities. Larger and longer follow-up studies could be helpful to further investigate this topic.

Rotator cuff tears are commonly associated with shoulder pain and disability. Arthroscopic repair has evolved as the preferred surgical procedure to treat these tears when conservative treatment is not effective.[8,16] Different arthroscopic techniques have been developed and optimized in recent years, aiming to obtain maximal fixation, mechanical stability, and anatomic reconstruction of the tendon-bone junction over the footprint.[19] These interventions used to rely on knot-tying double-row techniques, but the advent of knotless transosseous equivalent procedures introduced a new variable to the debate.[11]

It has been postulated that the use of knotted anchors could be associated with a greater risk of retear by strangulation of the repaired tendon, compromising its vascularity.[19] With knotless techniques, excessive load and tendon strangulation would be diminished, improving tendon integrity.[21] It remains unclear whether this biomechanical difference would result in superior structural outcomes or lower retear rates.[8,16,19]

The purpose of this study is to evaluate the available data and determine which technique is associated with lower retear rates. For its' biomechanical advantages, the authors' hypothesis is that knotless techniques would have lower retear rates.

Methods

Search strategy

A systematic literature search was performed to include studies published until June 6, 2022, involving arthroscopic rotator cuff repair using a knotted or knotless double-row or transosseous equivalent technique. Articles from PubMed and Google Scholar

Institutional review board approval was not required for this systematic review and meta-analysis.

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Table I
Studies that used knotted double-row rotator cuff repair arthroscopic techniques.

Study	Study design	Level of evidence	Total subjects	Age (mean)	M/F ratio	Follow-up duration (m)	Retear rate, %
Buyukdogan et al, 2021[3]	Retrospective case series	4	79 shoulders (76 patients)	55 (40-72)	36/40	120	21.3
Gerhardt et al, 2012[6]	Cohort study	3	20	61.2 (±7.5)	15/5	23.4	25
Lee SH et al, 2017[12]	Retrospective cohort study	3	59	59 (46-75)	27/32	6	15.7
Lee KH et al, 2018[13]	Retrospective cohort study	3	76	59.4	34/42	17.7	15.8
Peng et al, 2021[17]	Retrospective cohort study	3	88	45	37/51	24	3.4
Shin et al, 2021[20]	Retrospective cohort study	3	37	59.3 (±9.9)	18/19	6	8.1
Tashjian et al, 2018[23]	Cohort study	3	21	61	15/6	12	29
Voigt et al, 2010[24]	Case series	4	45*	62	Not given	12	28.9
Yamakado et al, 2019[26]	Prospective randomized trial	1	46	65.4 (±7.9)	24/22	12	6.5
Zafra et al, 2019[27]	Prospective comparative study	2	25	54.1 (±7)	13/12	12	4

*Total patients that performed postoperative magnetic resonance imaging.

Table II
Studies that used knotless transosseous equivalent rotator cuff repair arthroscopic procedures.

Study	Study design	Level of evidence	Total subjects	Age (mean)	M/F ratio	Follow-up duration (m)	Retear rate, %
Dukan et al, 2019[4]	Case series	4	65 shoulders (60 patients)	56 (±4)	36/24	24	12
El Azab et al, 2010[5]	Case series	4	20	58 (±8)	10/10	12	20
Hug et al, 2013[9]	Cohort study	3	22	63.3 (±7.2)	14/8	24	22.7
Ide et al, 2015[10]	Retrospective cohort study	3	36	61.6 (±8.1)	27/9	12	14
Tanaka et al, 2021[22]	Retrospective cohort study	3	212	64.8 (20-87)	127/85	6	12.2

Table III
Studies that compared knotted double-row vs. knotless transosseous equivalent rotator cuff repair arthroscopic procedures.

Study	Study design	Level of evidence	Total subjects	Age (mean)	M/F ratio	Follow-up duration (m)	Retear rate, %
Nemirov et al, 2022[16]	Retrospective comparative trial	3	117 KT	59.2 (±8.5)	82/35	24	6.1
			72 KL	55.1 (±8.6)	38/34	24	5.6
Boyer et al, 2012[2]	Prospective nonrandomized comparative study	3	38 KT	58 (47-72)	22/16	13	23.4
			35 KL	59 (44-68)	21/14	13	17.1
Heuberer et al, 2019[7]	Prospective comparative study	2	20 KT	64.8 (±7.7)	10/10	12	5
			17 KL	62.8 (±9.8)	5/12	12	5.8
Honda et al, 2018[8]	Case control study	3	29 KT	63.8 (±8.4)	17/12	24	24.1
			24 KL	65.1 (±9.6)	15/9	24	25
Kim et al, 2018[11]	Prospective comparative study	2	49 KT	59.4 (±7.5)	28/21	6	16.3
			48 KL	59.9 (±7.7)	24/24	6	29.2
Nakamizo et al, 2018[15]	Retrospective comparative study	3	46 KT	64.1 (±9.4)	20/26	12	6.5
			52 KL	65.8 (±8.5)	28/24	12	13.5
Rhee et al, 2012[18]	Cohort study	2	59 KT	57.6 (45-70)	30/29	6.8	18.6
			51 KL	61 (44-68)	30/21	6.8	5.9
Sahin et al, 2021[19]	Randomized controlled trial	1	42 KT	54.3 (±9.8)	12/30	9.7	19
			46 KL	55.8 (±8.2)	20/26	9.5	28.3
Xu et al, 2021[25]	Retrospective comparative study	3	158 KT	62.6 (±8.9)	65/93	12	17
			134 KL	63.9 (±9.1)	47/87	12	14.9

were extracted and analyzed by 2 independent reviewers following PRISMA guidelines.[14]

Search terms, defined before initiating the search, were: "Rotator cuff repair with double row knot OR transosseous equivalent knotless".

Eligible articles were included when they met the following criteria: 1) Arthroscopic rotator cuff repair using a knotted or knotless double-row or transosseous equivalent technique; 2) Clinical studies published in a peer-reviewed journal; 3) Studies reporting failure or retear rates assessed by magnetic resonance

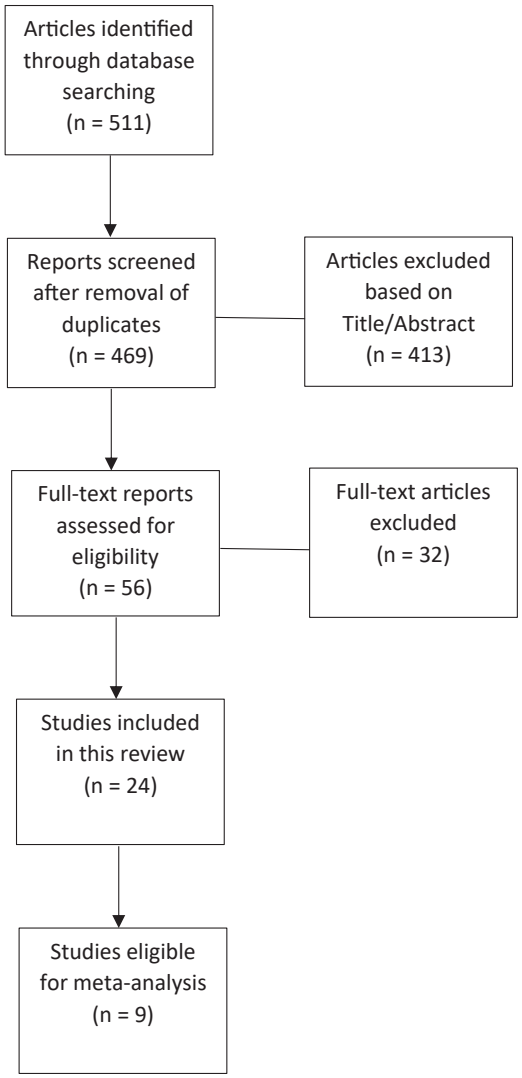

Figure 1 Articles' selection process following PRISMA guidelines.

Table IV
Total retear rate in studies that used only knotted double-row interventions.

Study	Retear cases	Total subjects	Retear rate, %
Buyukdogan et al, 2021[3]	17	79	21.3
Gerhardt et al, 2012[6]	5	20	25
Lee SH et al, 2017[12]	9	59	15.7
Lee KW et al, 2018[13]	12	76	15.8
Peng et al, 2021[17]	3	88	3.4
Shin et al, 2021[20]	3	37	8.1
Tashjian et al, 2018[23]	6	21	29
Voigt et al, 2010[24]	13	45	28.9
Yamakado et al, 2019[26]	3	46	6.5
Zafra et al, 2019[27]	1	25	4
Total	72	496	14.52

imaging; 4) Minimum of 6 months of follow-up; 5) Written in English.

Exclusion criteria were defined as follows: 1) Studies that do not differentiate between knotted and knotless techniques in their results; 2) Reviews or meta-analysis; 3) Cadaveric or laboratory studies; 4) Case reports; 5) Technical notes.

Table V
Total retear rate in studies that used only knotless transosseous equivalent techniques.

Study	Retear cases	Total subjects	Retear rate, %
Dukan et al, 2019[4]	8	65	12
El Azab et al, 2010[5]	4	20	20
Hug et al, 2013[9]	5	22	22.7
Ide et al, 2015[10]	5	36	14
Tanaka et al, 2021[22]	26	212	12.2
Total	48	355	13.52

Study selection

Data extraction was performed by two independent reviewers, who individually screened all titles, abstracts, and full texts of the searched articles. Disagreements were managed by consensus. A third reviewer was summoned when consensus could not be reached. After attentive review of the full-text articles, a final decision of the included articles was made. Significant data was retrieved from these, including author, year of publication, study design, sample size, quality of evidence, surgical procedure, follow-up duration, failure, and retear rates, as displayed in Tables I-III.

Data analysis

For reports that used only knotted double-row repair techniques or only knotless transosseous equivalent procedures, the retear rate was calculated by the following form:

$$\frac{sum\ of\ all\ retear\ cases}{sum\ of\ total\ subjects}$$

For studies comparing knotted and knotless techniques, a meta-analysis was performed using Review Manager 5.4.1[1] (Cochrane's Review Manager; Cochrane, London, England). Using Mantel-Haenszel statistics with a fixed effect model, statistical significance via 95% confidence intervals and P values was assessed. Forest plot has been displayed.

Results

A summary of the article selection process can be found in Figure 1. After screening a total of 469 discrete articles, 56 were read. After excluding 32 of these, 24 were selected for the review.

The included articles were published between 2010 and 2022. Of these, 2 reported level 1 evidence,[19,26] 4 reported level 2 evidence,[7,11,18,27] 14 reported level 3 evidence,[2,6,8-10,12,13,15-17,20,22,23,25] and 4 reported level 4 evidence.[3-5,24] Furthermore, 10 of the included studies aimed at knotted techniques' outcomes,[3,6,12,13,17,20,23,24,26,27] 5 used knotless techniques,[4,5,9,10,22] and 9 compared knotted and knotless procedures.[2,7,8,11,15,16,18,19,25]

A total of 1888 subjects were included, of which 1054 were treated by using a knotted double-row procedure and 834 by using a knotless transosseous equivalent technique. The mean age for all patients was 59.96 years old, being 58.69 years old for subjects submitted to knotted techniques and 61.57 years old for patients treated by knotless procedures. The male-to-female ratio was 947:888 for all patients (505:501 for knotted procedures and 442:387 for knotless techniques). The data for this ratio were not available in the report by Voigt et al.[24] Mean follow-up duration of all subjects was 17.62 months, being 22.02 months for knotted techniques and 12.06 months for knotless ones.

From reports describing only knotted double-row techniques,[3,6,12,13,17,20,23,24,26,27] 72 retear cases out of 496 subjects were retrieved, corresponding to a retear rate of 14.52%, as shown

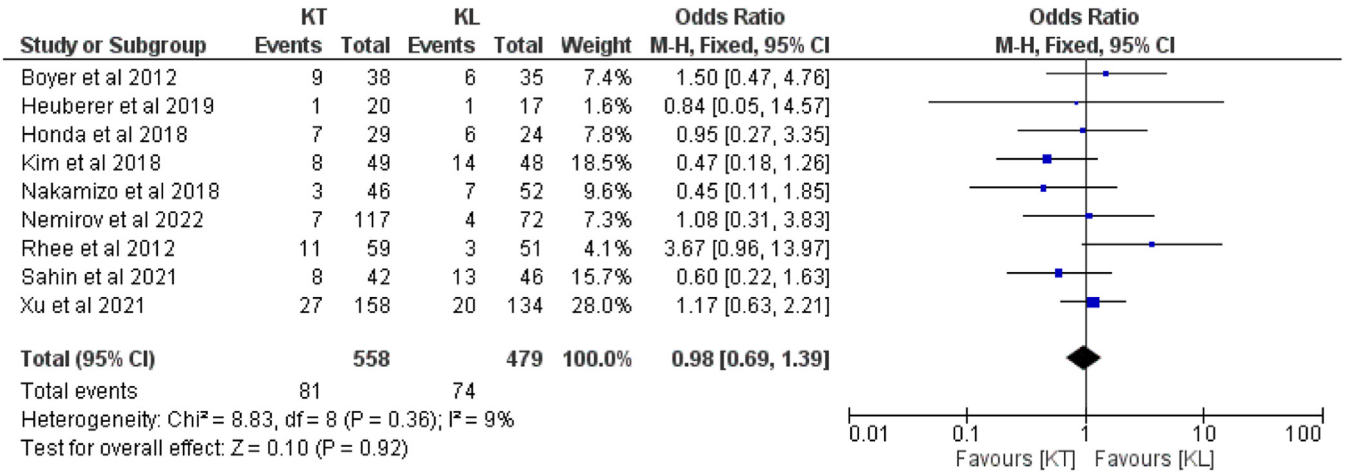

Figure 2 Forest plot comparing retear rates using knotted (KT) and knotless (KL) techniques. *CI*, confidence interval.

on Table IV. With a similar analysis, 48 retear cases out of 355 subjects were identified in articles using only knotless transosseous techniques,[4,5,9,10,22] with a retear rate of 13.52%, as displayed in Table V.

A meta-analysis was performed for the 9 studies[2,7,8,11,15,16,18,19,25] that compared knotted and knotless procedures, as seen in Figure 2. A statistically significant difference in retear rates between knotted and knotless techniques could not be shown in these studies.

Discussion

The performed review and meta-analysis could not show a statistically significant difference in retear rates between knotted double-row and knotless transosseous equivalent rotator cuff tears arthroscopic repair techniques.

Studies eligible for meta-analysis[2,7,8,11,15,16,18,19,25] showed strong homogeneity, and there was no statistical significance in retear rates of the compared techniques (P value = .92). Individually, only Rhee et al reported statistically significant differences in retear rates between knotted and knotless double-row techniques in their paper.[18]

This paper has some limitations. First, findings are limited by the quality of studies included. Of 24, only 2 reported level 1 evidence.[19,26] Second, surgical interventions performed by different authors have slight technical variations, which could be confounding. Third, this work could not control variables such as cuff tear size, tissue quality, or individual comorbidities that could influence the choice of surgical procedures as well as retear rates.

For example, concerning studies that compared knotted and knotless techniques, rotator cuff tears were mostly divided according to DeOrio and Cofield's classification.[15,16,18,19,25] However, Nemirov et al[16] and Rhee et al[18] excluded large sized tears and Xu et al[25] included only large tears.

Tissue quality can predict the risk of postoperative rotator cuff retear and can be evaluated by the presence of muscle atrophy and fatty infiltration before surgery. Muscle atrophy was considered only in five reports,[4-6,9,24] which used Thomazeau's classification, and fatty infiltration was determined in half of studies.[2-5,7,12,17-19,23-25] Goutallier classification modified by Fuchs was used in most cases.

Sugaya's classification was used to evaluate retear rates in most studies. Sugaya's grades 4 and 5 were generally assumed as retears, except for four studies[4,11,22,24] that considered retears Sugaya's grades 3 to 5. Six reports did not describe how retear rates were determined.[5,10,16,18,20,27]

Despite its limitations, this study enlightens the current state of knowledge regarding retear rates after cuff tear arthroscopic repair using knotted double-row or knotless transosseous equivalent techniques.

Conclusion

The authors conclude that a statistically significant difference in retear rates after cuff tear arthroscopic repair between knotted double-row and knotless transosseous equivalent procedures could not be shown. Larger and longer follow-up studies could be helpful in the future to further investigate this topic and the necessity to control all variables directly correlated with prognosis.

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