

All-Suture Versus Conventional Solid Suture Anchors in Arthroscopic Rotator Cuff Repair: A Systematic Review and Meta-analysis of Clinical, Structural, and Anchor-Related Outcomes

Usman Amjad Mehmood Yaqoob¹, Feras Hussain Almarzooq¹, Noor Marwan AlAnsari¹, Abdulhakim Motea Hezam²

¹ Orthopedic and Trauma Specialist, Government Hospitals

² Orthopedic Resident, Government Hospitals

*Corresponding author: Usman Amjad Mehmood Yaqoob, usmanayaqoob@gmail.com

"Cite this Article" Received: 03 February 2026; Accepted: 01 March 2026; Published: 15 March 2026

Author Contributions: Concept: UAMY, AMH; Design: UAMY, FHA, AMH; Data Collection: UAMY, FHA, NMA; Analysis: UAMY, FHA, NMA, AMH; Drafting: UAMY, FHA, NMA, AMH. **Ethical Approval:** NA. **Informed Consent:** NA; **Conflict of Interest:** The authors declare no conflict of interest. **Funding:** No external funding; **Data Availability:** Available from the corresponding author on reasonable request; **Acknowledgments:** NA

ABSTRACT

Background: All-suture anchors were developed to preserve greater tuberosity bone while providing fixation for arthroscopic rotator cuff repair. Although biomechanical evidence suggests performance comparable with conventional solid anchors, uncertainty remains regarding postoperative function, tendon healing, perianchor bone response, and anchor-related complications. **Objective:** To systematically evaluate and quantitatively compare clinical, structural, and anchor-related outcomes of all-suture versus conventional solid suture anchors in arthroscopic rotator cuff repair. **Methods:** PubMed was searched from inception through July 22, 2026 for comparative adult clinical studies evaluating all-suture anchors against metallic, polyetheretherketone, bioabsorbable, biocomposite, or other solid-body anchors. Randomized and nonrandomized comparative studies and within-patient imaging comparisons were eligible. Continuous outcomes were summarized as mean differences (MDs) and dichotomous outcomes as risk ratios (RRs), with 95% confidence intervals (CIs), using random-effects meta-analysis. Anchor-level imaging studies with non-independent observations were synthesized separately. **Results:** Thirteen comparative studies were included, and eight contributed to at least one patient-level meta-analysis. No significant differences were observed in Constant-Murley score (MD 2.43, 95% CI -0.87 to 5.73; $I^2=86\%$), ASES score (MD -1.77, 95% CI -5.66 to 2.12; $I^2=0\%$), VAS pain (MD -0.37, 95% CI -1.65 to 0.91; $I^2=85\%$), DASH score (MD -3.50, 95% CI -14.80 to 7.80; $I^2=78\%$), or forward flexion (MD 2.38°, 95% CI -2.12° to 6.87°; $I^2=0\%$). Structural failure was also inconclusive (RR 0.55, 95% CI 0.15 to 2.07; $I^2=53\%$). Patient-level perianchor fluid or cyst formation was less frequent with all-suture anchors (RR 0.47, 95% CI 0.25 to 0.89; $I^2=8\%$). Bone marrow edema and pullout estimates were heterogeneous and imprecise. **Conclusion:** All-suture anchors provide clinical and structural outcomes broadly comparable with conventional solid anchors while offering a bone-preserving fixation option. A lower risk of perianchor fluid or cyst formation was observed, but this finding was based on limited evidence. Larger randomized studies with standardized imaging and longer follow-up are required. **Keywords:** rotator cuff repair; suture anchor; arthroscopy; PEEK anchor; tendon healing; perianchor cyst; meta-analysis.

INTRODUCTION

Rotator cuff disease is a major cause of shoulder pain, weakness, and functional limitation, and its prevalence increases substantially with advancing age (1). When conservative management is insufficient and surgical repair is indicated, arthroscopic rotator cuff repair aims to restore tendon attachment to the greater tuberosity while providing sufficient mechanical stability for tendon-to-bone healing (2,3). Suture anchors are integral to modern single-row, double-row, and transosseous-equivalent repair constructs, and their design may influence fixation security, preservation of tuberosity bone, local osseous response, and the feasibility of subsequent revision surgery (2-4).

Conventional suture anchors generally incorporate a solid implant body composed of metal, polyetheretherketone (PEEK), bioabsorbable polymer, or biocomposite material (2,3). Although these devices have an established role in arthroscopic rotator cuff repair, insertion requires removal of tuberosity bone and may be associated with implant-related concerns such as perianchor cyst formation, osteolytic change, tunnel enlargement, migration, or technical difficulty during revision procedures (2,4). Imaging studies have further demonstrated that the osseous response surrounding anchors may vary according to implant composition, anchor position, repair configuration, and follow-up duration (14-17). These observations are clinically relevant because preservation of bone stock is particularly important when multiple anchors are required or when future revision fixation may be necessary (2,4).

All-suture anchors, also referred to as soft or textile anchors, were developed as a bone-preserving alternative to conventional solid-body anchors (2,3). They achieve fixation through expansion of high-strength suture material beneath the cortical surface after insertion through a comparatively small drill tunnel, thereby reducing the amount of bone removed during anchor placement (2,3). Their reduced osseous footprint may facilitate placement of multiple anchors within a limited tuberosity area and preserve bone for potential revision procedures (2-4). However, fixation with all-suture anchors depends substantially on cortical integrity, correct insertion trajectory, and complete deployment of the implant (4). Consequently, concerns remain regarding intraoperative pullout, anchor settling, tunnel enlargement, and fixation reliability in patients with compromised bone quality (2-4). Anchor pullout during rotator cuff repair is multifactorial and may be influenced by bone mineral quality, insertion site, anchor design, insertion technique, and the mechanical environment of the repair construct (4).

Earlier evidence evaluating all-suture anchors was dominated by biomechanical investigations and relatively small clinical series (2,3). Ergün et al. systematically reviewed the clinical and biomechanical performance of all-suture anchors and reported generally encouraging fixation characteristics, while emphasizing the limited quantity and quality of available clinical evidence (2). Subsequently, Yang et al. conducted a systematic review and network meta-analysis of the biomechanical performance of different suture anchors used in rotator cuff repair and found that all-suture anchors demonstrated broadly comparable mechanical performance with alternative anchor types (3). However, laboratory measures such as ultimate failure load, stiffness, and displacement do not directly establish whether different anchor designs result in equivalent postoperative pain, functional recovery, tendon healing, structural integrity, or implant-related complications in clinical practice (2,3).

The clinical evidence base has expanded substantially since these earlier reviews. Di Gennaro et al. compared all-suture with bioabsorbable anchors and evaluated functional, pain, imaging, and structural outcomes following rotator cuff repair (5). Piatti et al. subsequently compared all-suture and metallic anchors with assessment of both structural and functional properties (6). Higher-level comparative evidence has also emerged from the prospective multicenter randomized trial by Yan et al., which reported clinical outcomes, tendon integrity, and anchor-related complications following all-suture and solid-anchor fixation (7). Feldman et al. examined patient-reported outcomes following double-row suture-bridge repair using all-suture or solid medial-row anchors (8), whereas Keçeci et al. evaluated clinical outcomes and anchor pullout risk in repairs performed with all-suture versus metal anchors (9). Gonzalez-Morgado et al. extended the evidence to subscapularis repair and reported comparable postoperative outcomes between all-suture and hard-body fixation (10). More recent comparative studies have evaluated soft versus metal anchors in single-row repair and all-suture versus metal anchors in multicenter randomized settings, further broadening the available evidence across different repair techniques and patient populations (11,12).

Despite this expanding literature, uncertainty remains regarding whether the theoretical bone-preserving advantages of all-suture anchors translate into clinically meaningful benefits. Existing comparative studies differ in tendon involved, tear characteristics, repair configuration, anchor type, comparator material, rehabilitation protocol, duration of follow-up, and outcome definitions (5-12). This

heterogeneity is particularly relevant for structural outcomes because nonhealing, partial retear, complete retear, and tendon-specific failure do not represent identical clinical events (5-7,10,13). Likewise, anchor-related imaging findings such as low-grade perianchor fluid, high-grade cyst formation, marrow edema, and tunnel change may have different biological implications and temporal patterns (5,12-17).

Perianchor bone response represents an especially important area of uncertainty. Ro et al. reported differences in perianchor cyst formation among all-suture, bioabsorbable, and PEEK anchors following arthroscopic rotator cuff repair (14). Kim et al. demonstrated that perianchor fluid formation varied among all-suture, PEEK, and biocomposite devices (15), while Matijakovich et al. described longer-term cystic changes around anchors after rotator cuff repair (16). Cole et al., using different anchor types within the same shoulder, found broadly similar higher-grade cyst formation between all-suture and conventional anchors despite differences in lower-grade fluid signal (17). More recently, Gül et al. reported less perianchor fluid formation around all-suture anchors than around PEEK anchors in a propensity score-matched comparison (13). Collectively, these findings indicate that anchor-related bone reactions may depend on implant material, imaging definition, anchor position, and follow-up interval rather than solely on whether an implant is categorized as soft or solid (13-17).

Interpretation of this imaging literature is additionally complicated by the unit of analysis. Several investigations assessed multiple anchors within the same shoulder, meaning that individual anchor observations are not statistically independent because they share the same patient-level biological and mechanical environment (15-17). Such anchor-level evidence is clinically informative but should be distinguished from patient-level comparative outcomes when quantitative synthesis is undertaken. Failure to make this distinction may produce overly precise estimates and obscure important differences between tendon healing, patient-level complications, and local anchor-related imaging abnormalities.

Accordingly, an updated systematic review and meta-analysis focused specifically on direct clinical comparisons between all-suture and conventional solid suture anchors in arthroscopic rotator cuff repair is warranted. Previous syntheses primarily summarized early clinical experience or biomechanical performance (2,3), whereas the subsequent literature now includes randomized trials, comparative cohorts, propensity-matched studies, and detailed imaging investigations evaluating clinically relevant outcomes (5-17). The primary objective of this systematic review and meta-analysis was therefore to compare postoperative shoulder function and pain between all-suture and conventional solid anchors following arthroscopic rotator cuff repair. Secondary objectives were to compare range of motion, tendon healing and structural failure, anchor pullout and related complications, perianchor fluid or cyst formation, and bone marrow edema. The review additionally distinguished patient-level evidence from anchor-level imaging observations to provide a clinically and methodologically appropriate synthesis of the current comparative evidence.

MATERIALS AND METHODS

Protocol and reporting framework

This systematic review and meta-analysis was prepared in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement and the PRISMA-S extension for reporting literature searches (19,20). The methods of quantitative synthesis were informed by recommendations in the Cochrane Handbook for Systematic Reviews of Interventions (18). The review was designed to synthesize direct comparative clinical evidence evaluating all-suture anchors against conventional solid-body suture anchors in arthroscopic rotator cuff repair.

Eligibility criteria

Studies were eligible if they included adults undergoing arthroscopic repair of partial- or full-thickness rotator cuff tears and directly compared fixation using an all-suture, all-soft, soft, or textile anchor with

a conventional solid-body anchor. Eligible conventional comparators included metallic, polyetheretherketone (PEEK), bioabsorbable, biocomposite, or other hard-body suture anchors. Randomized controlled trials, prospective comparative studies, retrospective comparative cohorts, matched or case-control studies, and within-patient comparative imaging studies were eligible when they reported at least one relevant clinical, structural, or anchor-related outcome.

Cadaveric, animal, and purely biomechanical investigations were excluded because the objective was to evaluate clinical and postoperative imaging outcomes. Technical notes, case reports, noncomparative case series, studies of labral or biceps procedures without rotator cuff repair, and studies in which the comparison did not include a conventional solid-body anchor were also excluded. Reports arising from overlapping patient cohorts were evaluated to avoid duplicate inclusion of the same participants in a given synthesis; where overlapping reports provided complementary information, the most appropriate report was used for each outcome.

Information source and search strategy

PubMed was searched from database inception through July 22, 2026. The search combined terms relating to rotator cuff pathology, suture anchors, all-suture or soft-anchor technologies, and arthroscopic repair. Comparator terminology was not mandatory because the material or design of the conventional anchor was frequently described only within the methods of individual studies rather than in the title or abstract.

The PubMed search strategy was:

("Rotator Cuff"[Mesh] OR "Rotator Cuff Injuries"[Mesh] OR "rotator cuff"[tiab] OR "rotator cuff tear"[tiab] OR supraspinatus[tiab] OR infraspinatus[tiab] OR subscapularis[tiab]) AND ("Suture Anchors"[Mesh] OR "suture anchor"[tiab] OR "all-suture anchor"[tiab] OR "all suture anchor"[tiab] OR "all-soft anchor"[tiab] OR "soft anchor"[tiab] OR "soft suture anchor"[tiab] OR "textile anchor"[tiab] OR Q-Fix[tiab] OR QFIX[tiab] OR Juggernaut[tiab] OR Iconix[tiab] OR Y-Knot[tiab] OR FiberTak[tiab]) AND (arthroscop[tiab] OR repair*[tiab] OR fixation[tiab]).*

The search and reporting strategy followed PRISMA-S principles to permit reproducibility of the PubMed search (20). Study-selection counts are presented in the PRISMA flow diagram and Results section rather than within the methodological description.

Study selection and data extraction

Records identified by the search were screened for relevance to arthroscopic rotator cuff repair and comparative anchor fixation. Potentially eligible reports underwent full-text assessment against the prespecified eligibility criteria. Before submission, full-text eligibility and the extracted study data were independently rechecked by two reviewers as a verification step. Discrepancies were resolved through discussion and consensus, with third-reviewer adjudication available when required. This verification step was undertaken to ensure consistency between the eligibility criteria, extracted data, study-characteristics table, and quantitative analyses.

Data extracted from eligible studies included study design, sample size, treatment-group denominators, rotator cuff repair setting, tendon or repair configuration where specified, all-suture anchor type, conventional comparator material, duration of follow-up, and reported clinical, structural, and anchor-related outcomes. For continuous outcomes, group sample size, mean, and standard deviation were extracted when reported in a form suitable for quantitative synthesis. Dichotomous outcomes were extracted as event counts and corresponding group totals (18).

When an exact event count could be reconstructed unambiguously from a reported percentage and a clearly defined denominator, the reconstructed value was retained only when the calculation produced an unequivocal count. Such values were treated as reconstructed rather than directly reported data. Data expressed only as medians without an appropriate measure of dispersion, adjusted estimates without compatible raw outcome data, or qualitative statements that could not be converted reliably into group-level numerical data were not transformed into unverified means, standard deviations, or event counts (18). Studies that met the eligibility criteria but did not provide data in a form compatible with a particular meta-analysis remained eligible for the systematic review and were synthesized narratively for that outcome.

For multi-arm studies containing more than one eligible conventional solid-anchor comparator, conventional comparator arms were combined when they represented clinically appropriate components of the same comparison and when combination did not result in double counting of the all-suture group. For dichotomous outcomes, event counts and denominators of compatible conventional-anchor arms were summed. This approach allowed multi-arm studies to contribute a single independent comparison to the relevant patient-level analysis in accordance with standard meta-analytic principles (18).

Outcomes

The principal functional outcomes were final Constant-Murley score, American Shoulder and Elbow Surgeons (ASES) score, Disabilities of the Arm, Shoulder and Hand (DASH) score, and visual analogue scale (VAS) pain score. Range of motion was represented by final forward flexion when at least two studies reported sufficiently compatible data for quantitative synthesis.

Structural outcomes included tendon nonhealing, partial or complete retear, and advanced structural failure according to the definitions reported by individual studies. Because definitions of structural failure differed across studies and tendons, analyses combining these outcomes were considered exploratory rather than representing a single uniform failure construct.

Anchor-related outcomes included intraoperative or postoperative pullout, migration, perianchor fluid or cyst formation, and bone marrow edema. Bone marrow edema was separated according to earlier and later postoperative imaging intervals where compatible data were available because its frequency and interpretation may vary over time. Perianchor fluid and cyst outcomes were pooled only when the study-level definitions and statistical unit were sufficiently compatible.

Unit-of-analysis considerations

The principal quantitative syntheses were conducted at the patient level. Particular attention was given to studies reporting outcomes for multiple anchors positioned within the same shoulder because individual anchors from the same patient are correlated observations rather than statistically independent units (18). Anchor-level imaging studies were therefore not entered into conventional patient-level meta-analyses when cluster-adjusted estimates, paired-effect data, or another statistically appropriate patient-level measure could not be obtained. These investigations were retained for descriptive synthesis because they provided clinically relevant information regarding local perianchor reactions.

For anchor-related complications, patient-level event data were used whenever the published report permitted identification of the number of affected patients. When more than one anchor-related event occurred in a single patient, the patient was counted once for a patient-level risk analysis rather than treating each affected anchor as an independent patient event. Studies with an irreconcilable anchor-level versus patient-level denominator were not combined as though the observations were independent.

Risk-of-bias assessment

Risk of bias was evaluated according to study design. Randomized controlled trials were assessed using domains consistent with the revised Cochrane Risk of Bias tool for randomized trials (RoB 2), including the randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of the reported result (22). Nonrandomized comparative studies were evaluated using ROBINS-I principles, with attention to confounding, participant selection, classification of interventions, deviations from intended interventions, missing data, outcome measurement, and selective reporting (23).

Additional methodological consideration was given to within-patient and anchor-level imaging studies because multiple anchors nested within the same shoulder may introduce unit-of-analysis concerns. Potential confounding related to anchor position, repair configuration, comparator material, treatment era, and surgeon selection was considered when interpreting observational evidence. Risk-of-bias findings are reported separately from the methodological procedures.

Statistical analysis

Continuous outcomes measured on the same scale were summarized as mean differences (MDs) with 95% confidence intervals (CIs), whereas dichotomous outcomes were summarized as risk ratios (RRs) with 95% CIs (18). Random-effects meta-analysis was used because clinical and methodological heterogeneity was anticipated across studies with respect to anchor design, comparator material, tendon involvement, repair configuration, and follow-up. Between-study variance was estimated using the DerSimonian-Laird method (24), with study weighting based on inverse-variance principles.

For dichotomous outcomes containing a zero event in one treatment arm, a continuity correction of 0.5 was applied to all four cells of the corresponding 2×2 table before estimation of the risk ratio. Studies reporting zero events in both groups were retained in the systematic review and displayed where relevant but did not provide an estimable risk ratio for that particular analysis (18).

Statistical heterogeneity was assessed using Cochran's Q and quantified using the I^2 statistic (18,25). I^2 values of approximately 25%, 50%, and 75% were considered indicative of low, moderate, and high heterogeneity, respectively, while interpretation also considered the number of contributing studies, direction of effects, and clinical differences among studies (25). Because fewer than 10 studies contributed to every pooled outcome, formal assessment of small-study effects using funnel plots or statistical tests for publication bias was not undertaken (18).

Forest plots were generated from the extracted arm-level data and displayed study-specific effect estimates, 95% CIs, study weights, pooled random-effects estimates, and heterogeneity statistics. The plots were custom generated using Review Manager-compatible inverse-variance calculations and graphical conventions; they were not exported directly from the proprietary Review Manager software. Patient-level analyses and anchor-level descriptive evidence were kept distinct to avoid artificially increasing statistical precision through non-independent observations.

RESULTS

Study selection

The PubMed search yielded 1,012 unique records, all of which underwent title and abstract screening. Following screening, 22 reports were selected for full-text assessment. Nine reports were excluded at the full-text stage: eight did not include an eligible conventional solid-anchor comparator, and one represented an overlapping companion analysis of a cohort already represented by Feldman et al. (8,21). Thirteen independent comparative studies were therefore included in the systematic review, and eight contributed data to at least one patient-level quantitative synthesis (5-17). The study-selection process is summarized in Figure 1.

Study characteristics

The 13 included studies were published between 2019 and 2026 and comprised randomized multicenter trials, prospective comparative studies, retrospective comparative cohorts, propensity score-matched analyses, and within-patient or within-repair imaging studies (5-17). The included studies compared all-suture anchors with metallic, PEEK, bioabsorbable, biocomposite, or other conventional hard-body anchors. Clinical settings included general arthroscopic rotator cuff repair, supraspinatus repair, single-row repair, double-row suture-bridge repair, and subscapularis repair (5-13). Follow-up ranged from approximately eight months to nearly four years among studies for which follow-up duration was available.

The studies differed in the outcomes available for quantitative synthesis. Several reports provided compatible continuous or dichotomous patient-level data for functional, structural, or anchor-related outcomes, whereas others contributed only descriptive evidence because compatible group-level numerical data were unavailable in the current dataset. Yan et al. and Abdioglu and Peker were retained within the systematic review but did not contribute to the current pooled estimates (7,11). Three imaging investigations evaluated multiple anchors within the same patients or shoulders and were therefore synthesized separately because the individual anchors did not represent statistically independent observations (15-17). Characteristics of the included studies are summarized in Table 1.

Table 1. Characteristics of studies included in the systematic review

Study	Design	Sample	Anchor comparison	Repair setting	Follow-up	Contribution to synthesis
Ro et al., 2019 (14)	Retrospective three-arm cohort	213: ASA 137; bioabsorbable 36; PEEK 40	All-suture vs bioabsorbable and PEEK	General arthroscopic RCR	Mean 9.6 months	Patient-level perianchor cyst analysis; conventional arms combined for quantitative comparison
Kim et al., 2019 (15)	Prospective anchor-level imaging comparison	73 patients; paired ASA comparison in 37 repairs	All-suture vs PEEK/biocomposite anchors	Multiple anchor types within repairs	Approximately 1 year	Descriptive imaging synthesis; paired discordant data unavailable for valid effect estimation
Matijakovich et al., 2021 (16)	Within-repair longitudinal MRI cohort	23 shoulders; 58 ASA vs 44 PLLA anchors	All-suture vs PLLA	Double-row repair; different row positions	Mean 113 weeks	Descriptive imaging synthesis because of clustering and row-position confounding
Cole et al., 2022 (17)	Within-patient retrospective MRI comparison	19 patients; 26 soft vs 45 hard anchors	All-suture vs conventional hard anchors	Hybrid RCR within the same shoulder	Mean approximately 20 months	Descriptive imaging synthesis because multiple anchors were clustered within patients
Di Gennaro et al., 2022 (5)	Comparative non-inferiority study	60: ASA 30; bioabsorbable 30	All-suture vs bioabsorbable	Supraspinatus repair	8 months	Constant-Murley, DASH, VAS, structural failure, and edema analyses
Piatti et al., 2023 (6)	Comparative cohort	40: ASA 20; metal 20	All-suture vs metallic	Small-to-medium supraspinatus tears	Approximately 44 months	Structural outcome included descriptively; both groups had zero advanced structural failures
Yan et al., 2024 (7)	Prospective multicenter randomized non-inferiority trial	120 randomized; 115 followed	All-suture vs solid anchor	Arthroscopic RCR	12 months	Included in systematic review; not included in current quantitative synthesis
Feldman et al., 2024 (8)	Retrospective cohort	352: ASA 280; solid 72	All-suture vs solid medial-row anchor	Double-row suture-bridge RCR	Approximately 2.8-3.6 years	ASES and VAS analyses; overlapping Crawford report excluded from duplicate quantitative inclusion
Keçeci et al., 2025 (9)	Retrospective comparative cohort	142: ASA 67; metal 75	All-suture vs metallic	Single- or double-row RCR	At least 12 months	Constant-Murley, DASH, forward-flexion, and pullout analyses
Gonzalez-Morgado et al., 2025 (10)	Retrospective comparative cohort	84: ASA 28; hard-body 56	All-suture vs hard-body anchor	Isolated or combined subscapularis repair	44.0 vs 48.4 months	ASES, VAS, forward-flexion, and structural analyses; outcome-specific structural denominators used
Abdioglu and Peker, 2026 (11)	Retrospective comparative case-control study	131: soft 81; metal 50	Soft vs metallic	Single-row RCR	NR	Included in systematic review; not included in current quantitative synthesis
Yang et al., 2026 (12)	Multicenter randomized clinical trial	87 randomized; 85 treated	All-suture vs metallic	Arthroscopic RCR	12 months	Constant-Murley, edema, and exploratory pullout analyses using outcome-specific denominators

Study	Design	Sample	Anchor comparison	Repair setting	Follow-up	Contribution to synthesis
Gül et al., 2026 (13)	Propensity score-matched retrospective cohort	68: ASA 34; PEEK 34	All-suture vs PEEK	Primary arthroscopic RCR	Minimum 2 years	Structural failure and patient-level perianchor fluid analyses

ASA, all-suture anchor; MRI, magnetic resonance imaging; NR, not reported; PEEK, polyetheretherketone; PLLA, poly-L-lactic acid; RCR, rotator cuff repair.

Risk of bias

Risk-of-bias considerations varied according to study design. In randomized trials, surgeon blinding was inherently impractical because the fixation devices were visually and technically distinguishable during implantation, while some structural and imaging endpoints were affected by sparse events or incomplete outcome-specific reporting (7,12). Observational comparisons were susceptible to confounding because anchor selection could have been influenced by treatment era, surgeon preference, tear characteristics, tendon involved, repair configuration, or other clinical factors associated with postoperative outcomes (5,6,8-11,13).

The anchor-level imaging studies presented additional methodological concerns because several anchors were assessed within individual shoulders, creating correlated observations (15-17). In Matijakovich et al., anchor material was also associated with row position, limiting separation of the effect of implant composition from the anatomical and mechanical differences between medial- and lateral-row fixation (16). These limitations were considered when interpreting the quantitative and descriptive findings.

Functional outcomes

Three studies comprising 284 participants provided compatible final Constant-Murley scores (5,9,12). Random-effects meta-analysis demonstrated no statistically significant difference between all-suture and conventional anchors (MD 2.43, 95% CI -0.87 to 5.73 ; $I^2=86\%$; Figure 2). Considerable heterogeneity was present. Di Gennaro et al. and Keçeci et al. demonstrated numerical differences favoring all-suture fixation, whereas the multicenter randomized trial by Yang et al. reported little between-group difference at final assessment (5,9,12).

Two studies involving 436 participants contributed final ASES scores (8,10). The pooled estimate showed no statistically significant difference between groups (MD -1.77 , 95% CI -5.66 to 2.12 ; $I^2=0\%$; Figure 3). No statistical heterogeneity was observed between the two study-specific estimates.

Final VAS pain scores were available from three studies involving 496 participants (5,8,10). The pooled analysis showed no statistically significant difference between all-suture and conventional anchors (MD -0.37 , 95% CI -1.65 to 0.91 ; $I^2=85\%$; Figure 4). Heterogeneity was substantial, with Di Gennaro et al. demonstrating a larger numerical difference favoring all-suture anchors than the larger Feldman and Gonzalez-Morgado cohorts (5,8,10).

Two studies involving 202 participants provided compatible final DASH scores (5,9). No statistically significant difference was observed between anchor groups (MD -3.50 , 95% CI -14.80 to 7.80 ; $I^2=78\%$; Figure 5). Considerable heterogeneity was present, and the contributing studies differed in the absolute level of postoperative disability.

Final forward flexion was reported in a form suitable for pooling by two studies involving 226 participants (9,10). The pooled estimate demonstrated no significant between-group difference (MD 2.38° , 95% CI -2.12° to 6.87° ; $I^2=0\%$; Figure 6).

The Yang trial contributed different denominators across individual outcomes because the numbers available for analysis varied according to the endpoint assessed (12). These outcome-specific denominators were retained in the corresponding analyses rather than replacing them with the overall randomized or treated sample.

Tendon healing and structural failure

Four studies involving 214 participants contributed information to the structural-failure forest plot (5,6,10,13). Piatti et al. reported no Sugaya type IV or V failures in either treatment group and therefore contributed descriptive information and participants to the forest plot but did not provide an estimable risk ratio (6). The pooled effect was consequently derived from the three studies containing at least one structural-failure event (5,10,13).

Across these three estimable studies, no statistically significant difference in structural failure was identified between all-suture and conventional anchors (RR 0.55, 95% CI 0.15 to 2.07; $I^2=53\%$; Figure 7). The analysis was considered exploratory because the contributing studies did not use a uniform definition of structural failure; outcomes included nonhealing, partial retear, and tendon-specific failure (5,10,13). The confidence interval was wide and did not exclude either clinically meaningful benefit or harm.

The Gonzalez-Morgado study included 84 participants in its complete clinical cohort, but the structural analysis was based on the smaller outcome-specific imaging denominators available for that endpoint (10). The denominators used in the meta-analysis therefore reflect participants contributing structural outcome data rather than the total cohort size.

Perianchor fluid and cyst formation

Two independent patient-level studies comprising 281 participants reported sufficiently compatible perianchor fluid or cyst outcomes for quantitative synthesis (13,14). All-suture anchors were associated with a lower risk of patient-level perianchor fluid or cyst formation than conventional anchors (RR 0.47, 95% CI 0.25 to 0.89; $I^2=8\%$; Figure 8). Heterogeneity was low, and both study-specific estimates were in the same direction.

Ro et al. included all-suture, bioabsorbable, and PEEK anchor groups (14). For quantitative comparison, the bioabsorbable and PEEK groups were combined as the conventional solid-anchor comparator so that the all-suture group was not entered more than once. Gül et al. directly compared all-suture with PEEK anchors in a propensity score-matched cohort (13). Although the pooled estimate favored all-suture fixation, the result was based on only two independent patient-level studies and involved different conventional comparator materials.

Bone marrow edema

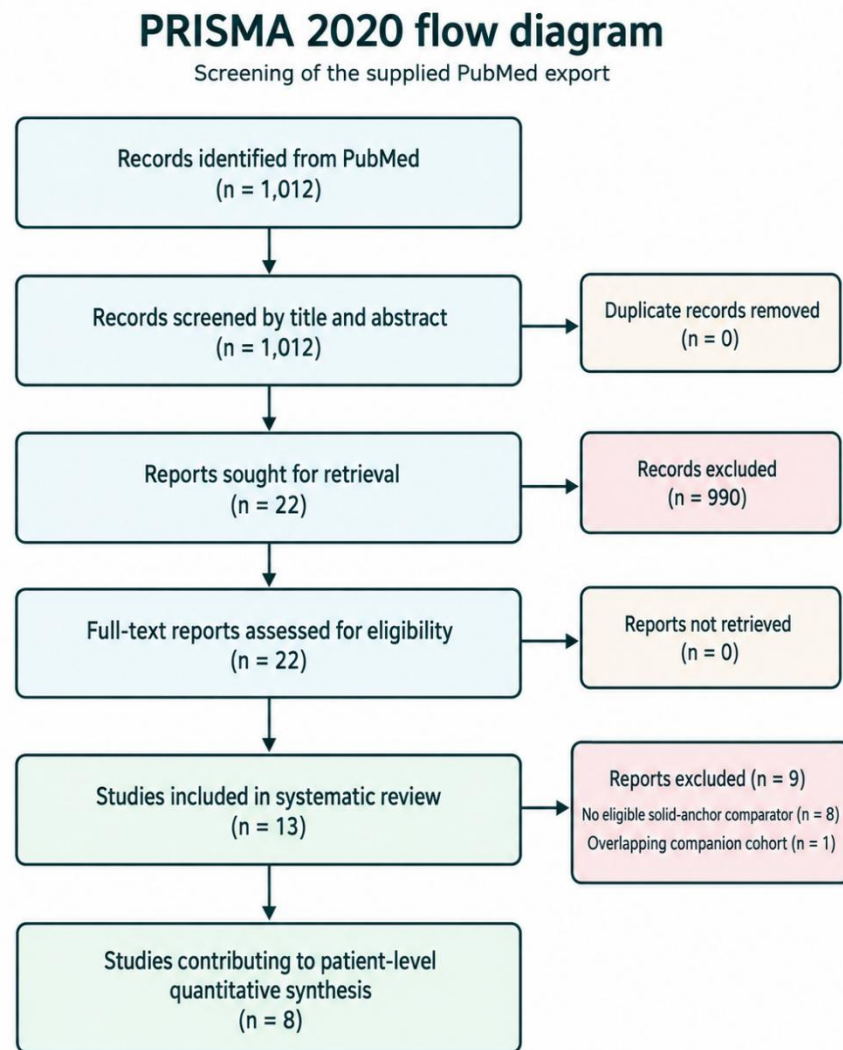
Two studies provided comparative data on postoperative bone marrow edema at earlier and later imaging intervals (5,12). At the earlier interval, the direction of the individual study effects differed substantially. Yang et al. observed more edema following all-suture fixation than following metallic-anchor fixation, whereas Di Gennaro et al. observed fewer edema events with all-suture anchors than with bioabsorbable anchors (5,12). The resulting pooled estimate showed no statistically significant difference and was highly imprecise (RR 1.51, 95% CI 0.12 to 19.21; $I^2=90\%$; Figure 9).

At the later imaging interval, the pooled estimate remained inconclusive (RR 0.29, 95% CI 0.01 to 7.88; $I^2=81\%$; Figure 10). Considerable heterogeneity persisted, with opposing study-specific effects and a very wide confidence interval. The edema findings therefore did not demonstrate a consistent direction of association across comparator materials and postoperative imaging intervals.

Anchor pullout and other complications

Comparative data on anchor pullout were sparse (7,9,12). Two studies comprising 227 participants contributed estimable patient-level data to the exploratory meta-analysis (9,12). The pooled result demonstrated no statistically significant difference between all-suture and conventional anchors, but the estimate was extremely imprecise (RR 0.45, 95% CI 0.01 to 17.02; $I^2=66\%$; Figure 11).

Keçeci et al. reported no pullout events among 67 all-suture repairs compared with seven events among 75 metal-anchor repairs (9). In the Yang trial, two anchor pullouts occurred within a single affected patient; because the quantitative synthesis was conducted at the patient level, this was represented as one affected patient rather than two independent patient events (12). The resulting pooled estimate should therefore be regarded as exploratory because of the rarity of events, heterogeneity, and the difference between the originally reported anchor-level event count and the patient-level analytical unit. A reliable pooled estimate for revision or reoperation was not generated because events were uncommon and were not reported in sufficiently compatible patient-level form across studies (7,12).



Three within-patient or anchor-level MRI studies were synthesized descriptively because individual anchors were clustered within shoulders.
Counts apply only to the supplied PubMed file and must be updated after the complete multi-database search.

Figure 1. PRISMA flow diagram of study identification and selection. The PubMed search identified 1,012 unique records. After title and abstract screening, 22 reports underwent full-text assessment. Nine were excluded at full-text review: eight because an eligible conventional solid-anchor comparator was absent and one because it represented an overlapping companion analysis of an already included cohort. Thirteen independent comparative studies were included in the systematic review, and eight contributed to at least one patient-level meta-analysis.

Anchor-level imaging studies

Three studies evaluated imaging outcomes at the level of individual anchors positioned within the same patients or shoulders (15-17). These studies were retained as supportive evidence but were not combined with ordinary patient-level event data because doing so would have treated correlated observations as independent. Kim et al. assessed perianchor fluid associated with all-suture, PEEK, and biocomposite

anchors within rotator cuff repairs (15). Although the within-repair comparison provided relevant evidence regarding local osseous response, the paired discordant-event counts required for an appropriate paired effect estimate were unavailable. Matijakovich et al. evaluated longer-term perianchor cyst formation in double-row repairs and observed differences according to anchor type, although material and row position could not be separated analytically (16). Cole et al. directly compared soft and hard anchors within the same shoulder and reported more low-grade fluid signal around conventional hard anchors without a clear difference in higher-grade cyst formation (17). These anchor-level studies therefore complemented the patient-level analyses but were interpreted descriptively because their statistical structure differed fundamentally from studies in which each patient represented an independent analytical unit.

Table 2. Summary of patient-level random-effects meta-analyses

Outcome	Studies contributing to forest plot	Participants	Effect measure	Pooled effect (95% CI)	I ²
Final Constant-Murley score (5,9,12)	3	284	MD	2.43 (−0.87 to 5.73)	86%
Final ASES score (8,10)	2	436	MD	−1.77 (−5.66 to 2.12)	0%
Final VAS pain score (5,8,10)	3	496	MD	−0.37 (−1.65 to 0.91)	85%
Final DASH score (5,9)	2	202	MD	−3.50 (−14.80 to 7.80)	78%
Final forward flexion (9,10)	2	226	MD	2.38° (−2.12° to 6.87°)	0%
Structural failure/retear (5,6,10,13)	4 displayed; 3 estimable	214	RR	0.55 (0.15 to 2.07)	53%
Perianchor fluid/cyst formation (13,14)	2	281	RR	0.47 (0.25 to 0.89)	8%
Early bone marrow edema (5,12)	2	140	RR	1.51 (0.12 to 19.21)	90%
Later bone marrow edema (5,12)	2	142	RR	0.29 (0.01 to 7.88)	81%
Anchor pullout (9,12)	2	227	RR	0.45 (0.01 to 17.02)	66%

ASES, American Shoulder and Elbow Surgeons; CI, confidence interval; DASH, Disabilities of the Arm, Shoulder and Hand; MD, mean difference; RR, risk ratio; VAS, visual analogue scale. Structural failure included four studies in the forest plot, but only three provided an estimable risk ratio because Piatti et al. reported zero events in both groups. Structural-failure definitions differed among studies. The pullout analysis was performed at the patient level; two anchor pullouts occurring in one patient in Yang et al. were represented as one affected patient.

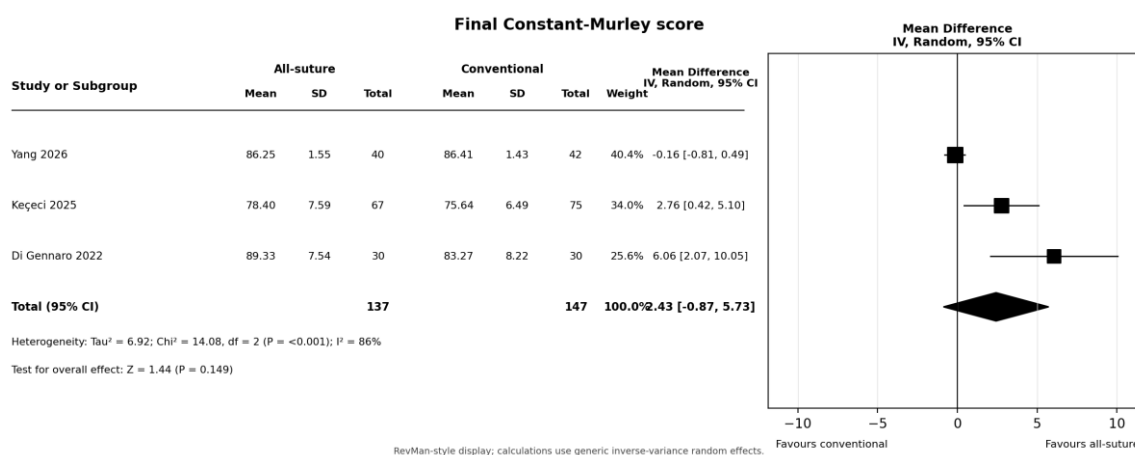


Figure 2. Forest plot comparing final Constant-Murley scores between all-suture and conventional solid anchors (5,9,12). Three studies comprising 284 participants were included. Random-effects meta-analysis showed no statistically significant between-group difference (MD 2.43, 95% CI −0.87 to 5.73), with substantial heterogeneity (I²=86%). Positive values favor all-suture anchors.

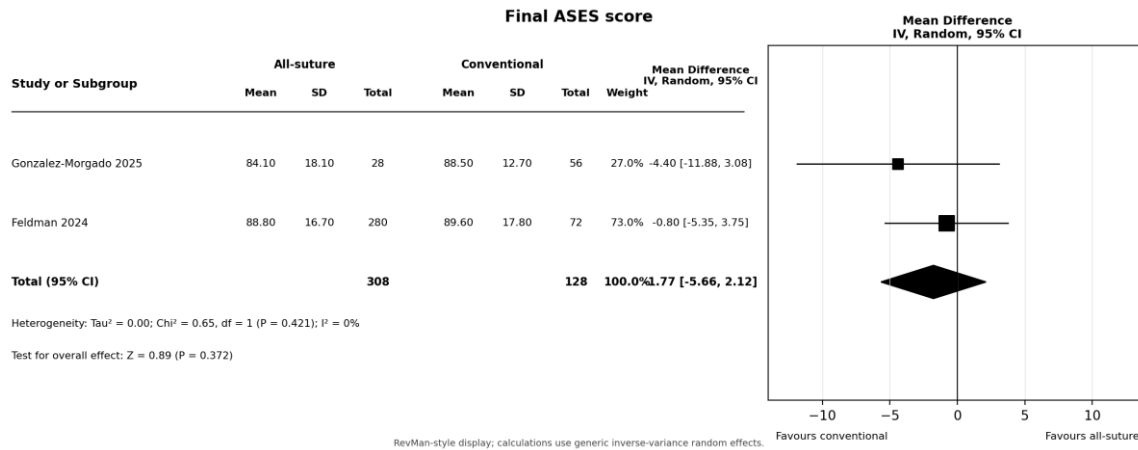


Figure 3. Forest plot comparing final ASES scores between all-suture and conventional solid anchors (8,10). Two studies comprising 436 participants were included. The pooled estimate demonstrated no statistically significant difference between anchor groups (MD -1.77 , 95% CI -5.66 to 2.12 ; $P=0\%$). Lower ASES scores represent poorer shoulder function.

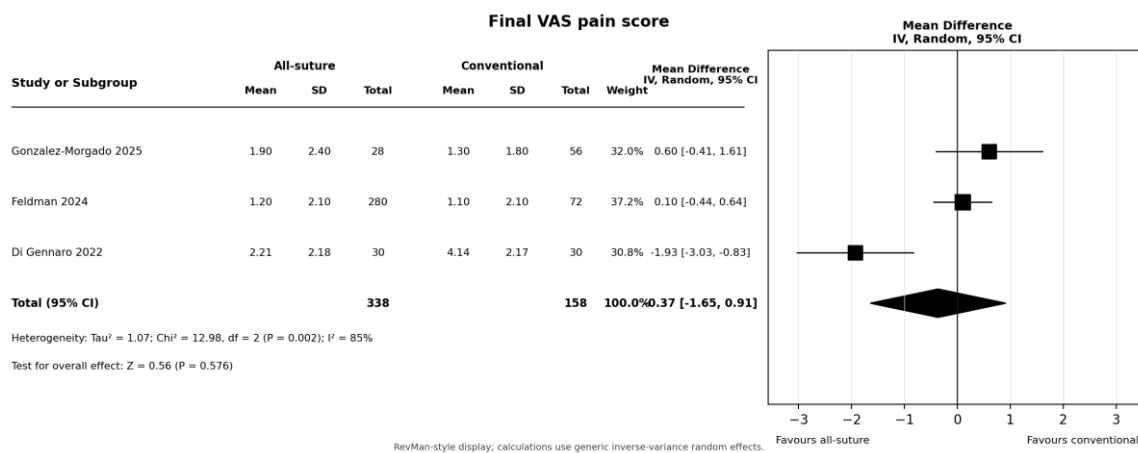


Figure 4. Forest plot comparing final VAS pain scores between all-suture and conventional solid anchors (5,8,10). Three studies involving 496 participants were included. No statistically significant between-group difference was observed (MD -0.37 , 95% CI -1.65 to 0.91), with substantial heterogeneity ($I^2=85\%$). Negative values favor all-suture anchors because lower VAS scores indicate less pain.

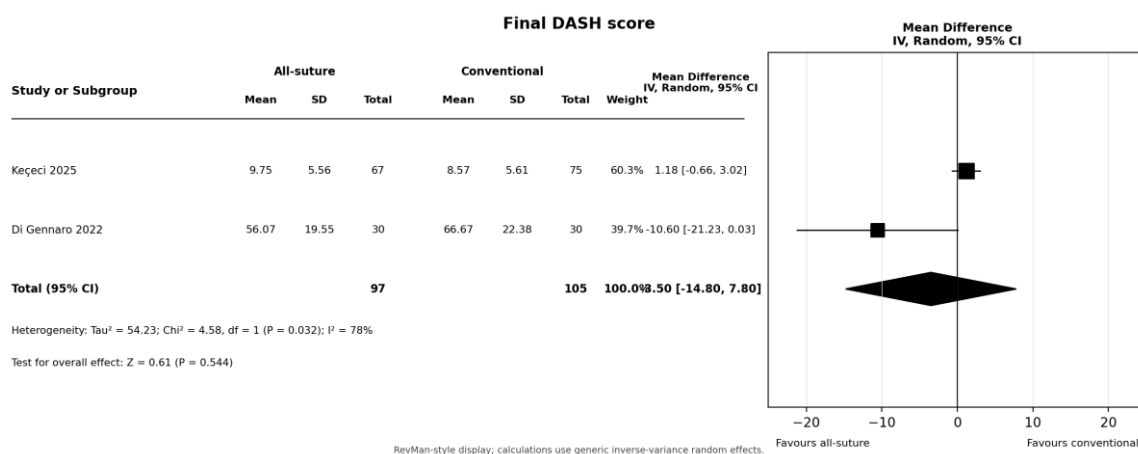


Figure 5. Forest plot comparing final DASH scores between all-suture and conventional solid anchors (5,9). Two studies involving 202 participants were included. The pooled estimate showed no statistically significant difference (MD -3.50 , 95% CI -14.80 to 7.80 ; $P=78\%$). Negative values favor all-suture anchors because lower DASH scores indicate less disability.

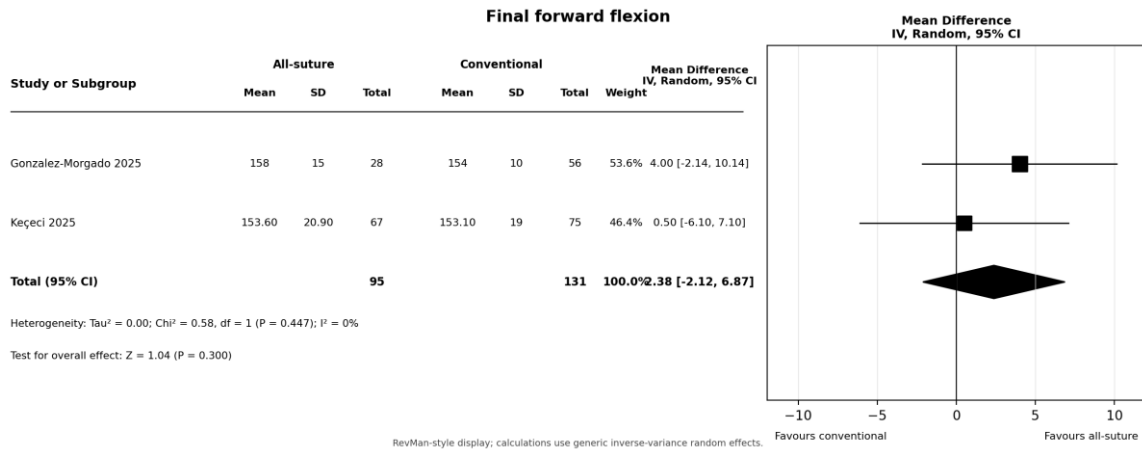


Figure 6. Forest plot comparing final forward flexion between all-suture and conventional solid anchors (9,10). Two studies comprising 226 participants were included. No statistically significant difference was identified (MD 2.38°, 95% CI -2.12° to 6.87°; $I^2=0\%$). Positive values indicate greater forward flexion in the all-suture group.

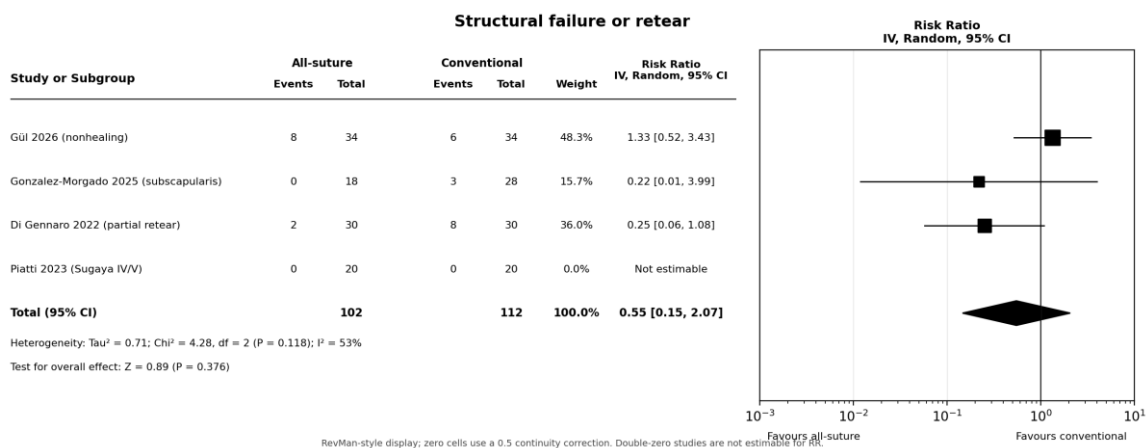


Figure 7. Exploratory forest plot of structural failure or retear following all-suture versus conventional solid-anchor fixation (5,6,10,13). Four studies involving 214 participants are represented. Piatti et al. reported zero events in both groups and therefore did not contribute an estimable risk ratio. The pooled effect from the three estimable studies showed no statistically significant difference (RR 0.55, 95% CI 0.15 to 2.07; $I^2=53\%$). Interpretation is exploratory because structural-failure definitions differed among studies.

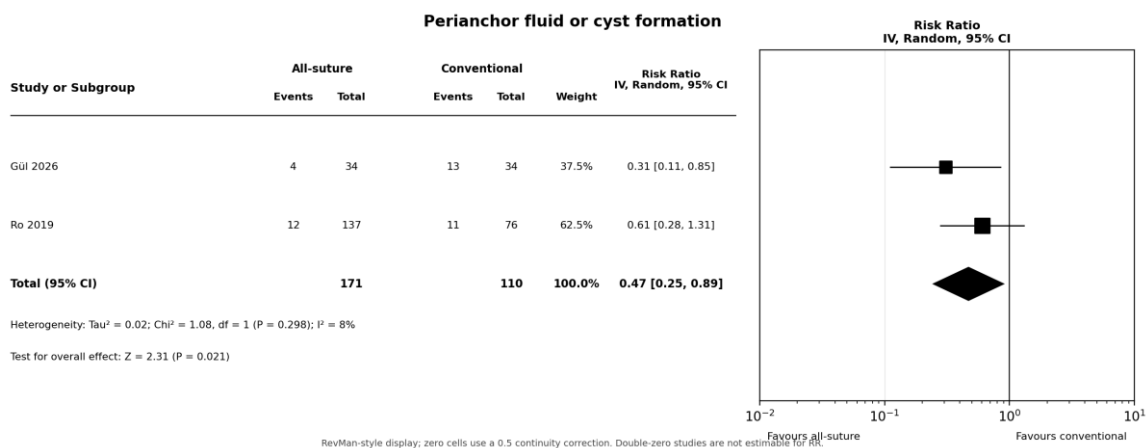


Figure 8. Forest plot of patient-level perianchor fluid or cyst formation following all-suture versus conventional solid-anchor fixation (13,14). Two studies involving 281 participants were included. All-suture anchors were associated with a lower observed event risk (RR 0.47, 95% CI 0.25 to 0.89; $I^2=8\%$). The result should be interpreted cautiously because only two independent patient-level studies contributed and the conventional comparator materials differed.

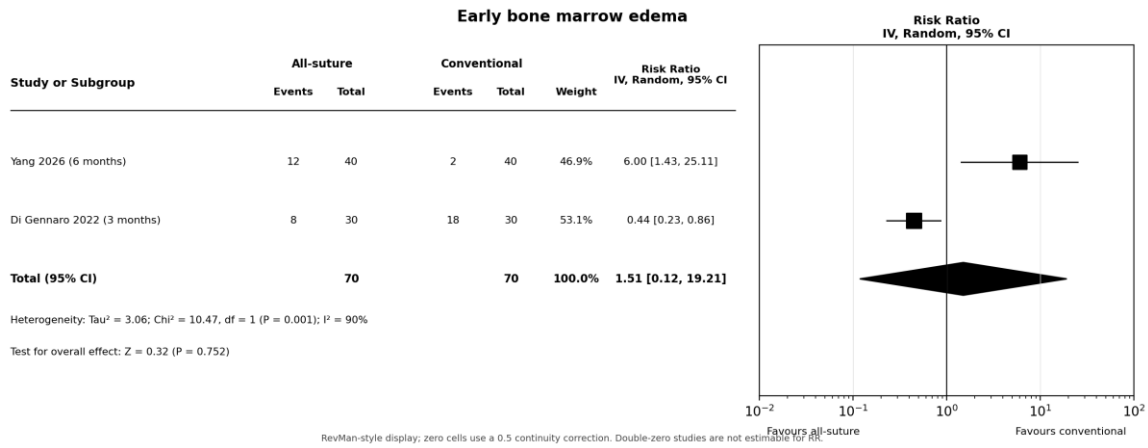


Figure 9. Forest plot of early postoperative bone marrow edema following all-suture versus conventional solid-anchor fixation (5,12). Two studies involving 140 participants were included. The pooled estimate was highly imprecise and demonstrated no statistically significant difference (RR 1.51, 95% CI 0.12 to 19.21), with very high heterogeneity ($I^2=90\%$). The study-specific effects were in opposing directions.

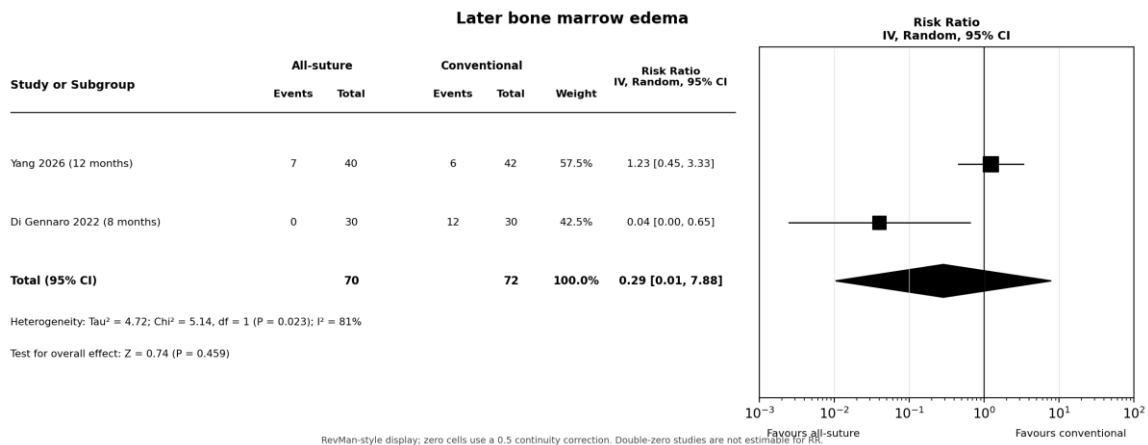


Figure 10. Forest plot of later postoperative bone marrow edema following all-suture versus conventional solid-anchor fixation (5,12). Two studies involving 142 participants were included. The pooled estimate remained inconclusive (RR 0.29, 95% CI 0.01 to 7.88; $I^2=81\%$). Considerable heterogeneity reflected opposing study-specific effects and differences in comparator material and imaging interval.

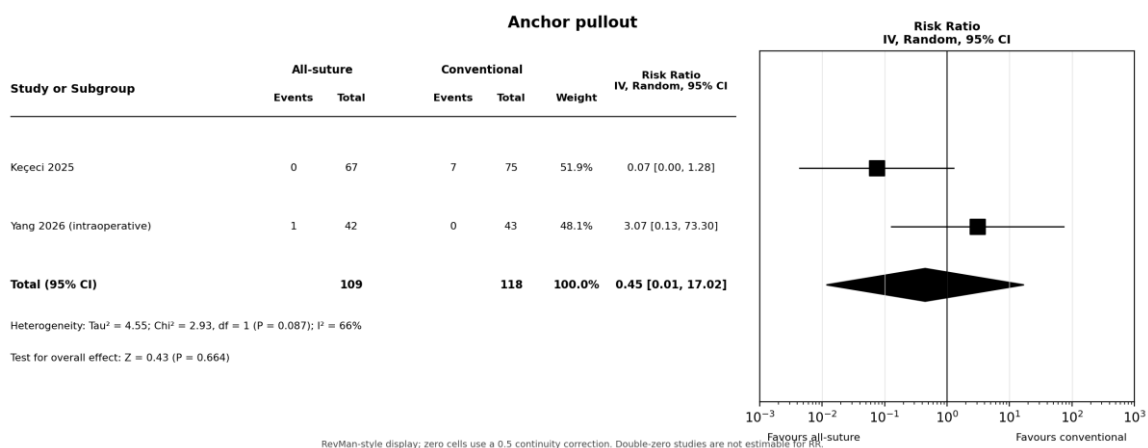


Figure 11. Exploratory forest plot of anchor pullout following all-suture versus conventional solid-anchor fixation (9,12). Two studies involving 227 participants contributed to the patient-level analysis. The pooled estimate was highly imprecise and showed no statistically significant difference (RR 0.45, 95% CI 0.01 to 17.02; $I^2=66\%$). In Yang et al., two anchor pullouts occurred in one patient and were represented as one affected patient for the patient-level analysis; accordingly, this result should be interpreted as exploratory.

DISCUSSION

This systematic review and meta-analysis indicates that all-suture anchors provide postoperative clinical outcomes broadly comparable with conventional solid-body anchors in arthroscopic rotator cuff repair. Across the pooled analyses of Constant-Murley score, ASES score, VAS pain, DASH score, and forward flexion, no statistically significant between-group differences were identified. Structural failure likewise showed no significant difference, although this analysis was exploratory because outcome definitions varied considerably among studies. The only pooled outcome demonstrating a statistically significant difference was patient-level perianchor fluid or cyst formation, which occurred less frequently with all-suture anchors. However, this finding was derived from only two studies and should therefore be interpreted as a potentially important signal rather than definitive evidence of superiority. Bone marrow edema and anchor pullout analyses were characterized by substantial imprecision and heterogeneity, precluding firm conclusions regarding these outcomes.

The absence of a clear functional advantage is consistent with the broader evidence suggesting that the principal benefit of all-suture anchors may relate to implant geometry and preservation of bone rather than superior postoperative shoulder function. Earlier systematic evidence demonstrated generally favorable clinical and biomechanical performance of all-suture anchors but also emphasized the limited clinical evidence available at that time (2). A subsequent network meta-analysis of biomechanical studies found that all-suture anchors achieved mechanical performance broadly comparable with other anchor designs used in rotator cuff repair (3). The present synthesis extends those observations to patient-level clinical outcomes by incorporating more recent randomized and comparative clinical evidence (5-13). Collectively, the available data suggest that satisfactory postoperative function can be achieved with either fixation strategy and that anchor selection alone is unlikely to determine final functional recovery.

The Constant-Murley analysis illustrates both the potential equivalence and the heterogeneity of the current evidence. Di Gennaro et al. reported a numerical advantage with all-suture fixation compared with bioabsorbable anchors, and Keçeci et al. similarly observed favorable numerical differences relative to metallic anchors, whereas Yang et al. found little difference between fixation groups in a multicenter randomized trial (5,9,12). The pooled estimate consequently remained nonsignificant and was accompanied by high heterogeneity. Differences in comparator material, repair configuration, patient characteristics, tear morphology, rehabilitation, and follow-up may contribute to this variability. Importantly, conventional anchors should not be regarded as a biologically homogeneous comparator category because metallic, PEEK, bioabsorbable, and biocomposite devices differ substantially in their material properties and local tissue responses (2-4).

ASES outcomes were considerably more consistent. Feldman et al. found similar patient-reported outcomes after double-row suture-bridge repair using either all-suture or solid medial-row anchors, while Gonzalez-Morgado et al. demonstrated comparable postoperative outcomes following subscapularis repair using all-suture or hard-body devices (8,10). The pooled ASES estimate was therefore close to the null with no observed heterogeneity. These findings are clinically relevant because they extend the comparison across different repair constructs and tendon-specific settings rather than restricting conclusions to a single surgical configuration. They also support the interpretation that preservation of bone with an all-suture implant does not appear to compromise patient-reported shoulder function.

Pain and disability outcomes were more heterogeneous. The pooled VAS and DASH estimates did not show significant differences between fixation strategies, but substantial statistical heterogeneity was present. Di Gennaro et al. reported comparatively favorable pain and disability outcomes with all-suture fixation, whereas larger observational cohorts showed smaller differences between anchor types (5,8-10). Such variability may reflect differences in baseline tear severity, postoperative rehabilitation, duration of follow-up, surgical construct, and comparator material. Pain after rotator cuff repair is multifactorial

and cannot reasonably be attributed solely to anchor composition, particularly when tendon healing, postoperative stiffness, rehabilitation exposure, repair tension, and concomitant pathology may also influence recovery.

The structural-healing findings require particularly cautious interpretation. No statistically significant difference in structural failure was detected, but the contributing studies used different definitions, including nonhealing, partial retear, and tendon-specific failure (5,6,10,13). These outcomes are not clinically interchangeable. A partial defect following posterosuperior cuff repair differs biologically and prognostically from complete failure or recurrent subscapularis disruption. Piatti et al. observed no advanced Sugaya type IV or V failure in either treatment group and therefore could not contribute an estimable risk ratio despite contributing structural information (6). The resulting pooled estimate should consequently be regarded as an exploratory summary of broadly related structural outcomes rather than a definitive estimate of retear risk. The wide confidence interval further indicates that the available evidence remains compatible with clinically meaningful benefit or harm.

The randomized evidence is particularly important when interpreting structural equivalence. Yan et al. reported equivalent clinical performance between an all-suture anchor and an established solid anchor in a prospective multicenter randomized trial, including assessment of tendon integrity and anchor-related complications (7). Yang et al. subsequently reported broadly comparable clinical outcomes in another multicenter randomized comparison of all-suture and metallic anchors (12). These trials strengthen the clinical evidence beyond the earlier observational literature, although relatively short follow-up and low frequencies of clinically important structural and anchor-related events continue to limit precision. Longer-term randomized evidence is therefore required before equivalence in uncommon outcomes such as revision, clinically important anchor migration, or late structural failure can be established confidently.

The finding of lower patient-level perianchor fluid or cyst formation with all-suture anchors deserves attention because implant-related bone response represents one of the principal theoretical distinctions between soft and solid fixation. Ro et al. demonstrated differences in perianchor cyst formation among all-suture, bioabsorbable, and PEEK anchors, while Gül et al. reported less perianchor fluid formation with all-suture than with PEEK anchors in a propensity score-matched comparison (13,14). The pooled estimate favored all-suture fixation and showed little statistical heterogeneity. This finding is biologically plausible because all-suture anchors require smaller drill tunnels and leave less rigid or degradable implant material within the greater tuberosity (2-4). Nevertheless, the result should not be generalized to every all-suture device or every conventional anchor because only two independent patient-level studies contributed to the analysis and their comparator materials differed (13,14).

The broader imaging literature reinforces the need for this restraint. Kim et al. demonstrated variation in perianchor fluid among all-suture, PEEK, and biocomposite anchors (15), while Matijakovich et al. reported longer-term cystic changes in double-row repairs in which anchor material and row position were not fully separable (16). Cole et al. compared soft and conventional anchors within the same shoulders and found differences in lower-grade fluid signal without a clear difference in higher-grade cyst formation (17). These studies suggest that local bone response is influenced by several interacting factors, including implant material, anchor position, bone quality, mechanical loading, and follow-up duration. Accordingly, low-grade fluid signal, marrow edema, tunnel enlargement, and clinically meaningful cyst formation should not be treated as interchangeable manifestations of a single adverse implant response.

The bone marrow edema analyses further demonstrate the importance of comparator material and imaging timing. Yang et al. observed greater early edema with all-suture anchors than with metallic anchors, whereas Di Gennaro et al. observed fewer edema events with all-suture than with bioabsorbable anchors (5,12). These opposing directions produced extremely high heterogeneity and wide confidence intervals at both earlier and later postoperative intervals. The findings therefore do not support a

consistent class effect of all-suture fixation on postoperative marrow edema. Instead, the local imaging response may depend on the characteristics of the specific comparator, timing of MRI assessment, insertion-related bone trauma, and subsequent remodeling. More standardized serial imaging would be required to distinguish transient postoperative signal change from clinically relevant implant-associated pathology.

Anchor pullout represents another clinically important but insufficiently resolved outcome. Secure all-suture fixation depends on appropriate deployment beneath an adequate cortical shell, while poor bone quality, insertion location, implantation technique, and local mechanical loading may increase the risk of anchor failure regardless of implant category (4). Keçeci et al. reported no pullouts in the all-suture group and several events with metal anchors, whereas Yang et al. reported two anchor pullouts occurring within one patient during all-suture fixation (9,12). The pooled estimate was consequently highly unstable, with a confidence interval spanning substantial potential benefit and harm. These sparse data are insufficient to establish comparative pullout risk. They do, however, emphasize that technical deployment and bone quality remain relevant even when a bone-preserving anchor is used.

An important methodological strength of this review was the separation of patient-level outcomes from anchor-level imaging observations. Several imaging investigations evaluated more than one anchor in the same shoulder (15-17). Treating each anchor as an independent patient would ignore within-patient correlation and artificially increase statistical precision, contrary to established meta-analytic principles (18). Anchor-level studies were therefore retained as clinically informative descriptive evidence but were not combined with independent patient-level outcomes when appropriate paired or cluster-adjusted estimates were unavailable. This distinction is particularly important in rotator cuff repair, where anchors within the same shoulder share patient bone quality, healing biology, rehabilitation exposure, and aspects of the mechanical repair environment.

The findings have practical implications for implant selection. Current evidence does not demonstrate that all-suture anchors provide superior postoperative function, pain relief, range of motion, or tendon healing compared with conventional solid anchors. Rather, their principal clinical value appears to be that comparable outcomes may be obtained while preserving a greater volume of tuberosity bone (2-4). This characteristic may be advantageous when several anchors are required within a limited footprint or when preservation of bone stock for possible revision is desirable. Conversely, conventional anchors remain established fixation options, and selection should account for local bone quality, tear characteristics, tendon involved, repair configuration, surgeon experience, implant-specific evidence, availability, and cost rather than relying solely on the broad classification of an anchor as soft or solid.

Several limitations should be considered when interpreting this review. First, the literature search was restricted to PubMed, which introduces a risk that relevant studies indexed exclusively in other bibliographic databases were not identified. Although the search was designed to be sensitive and did not require comparator terminology, a future update using multiple bibliographic databases would provide more comprehensive coverage. Second, the number of studies contributing to individual meta-analyses was small, with most outcomes represented by only two or three estimable studies. Consequently, heterogeneity estimates were unstable, subgroup analyses were not sufficiently supported, and formal assessment of publication bias was inappropriate (18). Third, the evidence base included both randomized trials and observational comparisons, and the latter remain vulnerable to confounding by treatment era, surgeon preference, tear characteristics, and repair configuration (8-11,13,23).

Fourth, substantial clinical heterogeneity existed in anchor design, conventional comparator material, tendon repaired, surgical construct, imaging schedule, and outcome definition. This was particularly important for structural failure and bone marrow edema, where clinically different outcomes were summarized within exploratory analyses. Fifth, not every eligible study contributed numerical data to every relevant quantitative outcome, reducing the completeness and precision of some pooled estimates. Sixth, several analyses relied on outcome-specific denominators rather than total study enrollment

because imaging or clinical data were available for only subsets of participants. Seventh, uncommon events such as pullout, migration, revision, and structural failure resulted in wide confidence intervals and limited power to detect potentially meaningful differences. Finally, the small number of studies available for each outcome prevented reliable evaluation of small-study effects or publication bias using funnel plots or regression-based methods (18).

Future studies should prioritize adequately powered randomized comparisons with standardized outcome definitions and longer follow-up. Clinical reporting should include established functional measures such as ASES and Constant-Murley scores together with pain, return to activity, revision surgery, and adverse events. Structural assessment should report complete tendon-integrity classifications with clearly defined patient-level denominators. Imaging studies should distinguish low-grade fluid signal, clinically relevant cyst formation, tunnel enlargement, marrow edema, migration, and tendon failure rather than combining these phenomena. Anchor manufacturer, implant dimensions, row position, number of anchors, repair configuration, and bone-quality characteristics should also be reported because these factors may modify implant performance. Such standardization would enable more informative device-specific comparisons and may ultimately determine whether particular all-suture designs offer advantages beyond preservation of bone.

CONCLUSION

All-suture anchors provide postoperative shoulder function, pain relief, range of motion, and structural outcomes that are broadly comparable with conventional solid anchors in arthroscopic rotator cuff repair. Patient-level perianchor fluid or cyst formation was less frequent with all-suture fixation in the available pooled evidence, but this finding was based on only two studies and does not establish class-wide superiority. Evidence regarding bone marrow edema and anchor pullout remains inconsistent and imprecise. Current findings therefore support all-suture anchors as a viable bone-preserving alternative to conventional solid fixation rather than as a universally superior implant. Larger randomized studies with standardized structural and imaging outcomes, clearly defined denominators, and longer follow-up are required to determine whether specific anchor designs provide clinically meaningful long-term advantages.

REFERENCES

1. Teunis T, Lubberts B, Reilly BT, Ring D. A systematic review and pooled analysis of the prevalence of rotator cuff disease with increasing age. *J Shoulder Elbow Surg.* 2014;23(12):1913-1921. doi:10.1016/j.jse.2014.08.001.
2. Ergün S, Akgün U, Barber FA, Karahan M. The clinical and biomechanical performance of all-suture anchors: a systematic review. *Arthrosc Sports Med Rehabil.* 2020;2(3):e263-e275. doi:10.1016/j.asmr.2020.02.007.
3. Yang YS, Shih CA, Fang CJ, Huang TT, Hsu KL, Kuan FC, et al. Biomechanical comparison of different suture anchors used in rotator cuff repair surgery: all-suture anchors are equivalent to other suture anchors. A systematic review and network meta-analysis. *J Exp Orthop.* 2023;10(1):45. doi:10.1186/s40634-023-00608-w.
4. Li X, Xiao Y, Shu H, Sun X, Nie M. Risk factors and corresponding management for suture anchor pullout during arthroscopic rotator cuff repair. *J Clin Med.* 2022;11(22):6870. doi:10.3390/jcm11226870.
5. Di Gennaro S, Lecce D, Tarantino A, De Cupis M, Bassetti E, Scarnera P, et al. Arthroscopic repair of rotator cuff injury with bioabsorbable suture anchor versus all-suture anchor: a non-inferiority study. *BMC Musculoskelet Disord.* 2022;23(1):1098. doi:10.1186/s12891-022-06061-7.

6. Piatti M, Gorla M, Alberio F, Omeljaniuk RJ, Rigamonti L, Gaddi D, et al. Comparison of all-suture anchors with metallic anchors in arthroscopic cuff repair: structural and functional properties and clinical suitability. *J Orthop*. 2023;39:66-69. doi:10.1016/j.jor.2023.04.006.
7. Yan H, Zhao L, Wang J, Lin L, Wang H, Wang C, et al. An all-suture anchor offers equivalent clinical performance to an established solid suture anchor in the arthroscopic repair of rotator cuff tears: a prospective, randomized, multicenter trial with 12-month follow-up. *Arthroscopy*. 2024;40(2):265-276. doi:10.1016/j.arthro.2023.06.056.
8. Feldman JJ, Ostrander B, Ithurburn MP, Fleisig GS, Tatum R, Ochsner MG, et al. The relationship between all-suture and solid medial-row anchors and patient-reported outcomes for double-row suture bridge rotator cuff repair. *Orthop J Sports Med*. 2024;12(8):23259671241262264. doi:10.1177/23259671241262264.
9. Keçeci T, Polat Y, Şahin AA, Alparslan M, Sipahioğlu S, Çıraklı A. Comparison of all-suture anchors and metal anchors in arthroscopic rotator cuff repair: short-term clinical outcomes and anchor pullout risk. *J Clin Med*. 2025;14(8):2619. doi:10.3390/jcm14082619.
10. Gonzalez-Morgado D, Ardebol J, Kilic AI, Noble MB, Galasso LA, Nugent M, et al. Postoperative outcomes are comparable between arthroscopic subscapularis repairs performed with either all-suture anchors or hard-body anchors. *Arthrosc Sports Med Rehabil*. 2025;7(2):101060. doi:10.1016/j.asmr.2024.101060.
11. Abdioğlu AA, Peker G. Clinical comparison of metal and soft suture anchors in single-row rotator cuff repair. *Indian J Orthop*. 2026;60(2):411-416. doi:10.1007/s43465-025-01554-8.
12. Yang R, Zhang Q, Zhuang C, Zhang Y, Sun L, Yuan B, et al. All-suture soft anchors versus metal anchors in arthroscopic rotator cuff repair: a multicenter randomized clinical trial. *Int J Surg*. 2026;112(4):9867-9874. doi:10.1097/JS9.0000000000004768.
13. Gül O, Ayazoglu MA, Yazıcı A, Durusoy S, Gürün E, Okutan AE. All-suture anchors exhibit less perianchor fluid formation independent of healing quality compared with polyetheretherketone anchors in arthroscopic rotator cuff repair: a propensity score-matched comparative study. *J Shoulder Elbow Surg*. Published online June 10, 2026. doi:10.1016/j.jse.2026.05.033.
14. Ro K, Pancholi S, Son HS, Rhee YG. Perianchor cyst formation after arthroscopic rotator cuff repair using all-suture-type, bioabsorbable-type, and PEEK-type anchors. *Arthroscopy*. 2019;35(8):2284-2292. doi:10.1016/j.arthro.2019.03.032.
15. Kim SH, Yang SH, Rhee SM, Lee KJ, Kim HS, Oh JH. The formation of perianchor fluid associated with various suture anchors used in rotator cuff repair: all-suture, polyetheretherketone, and biocomposite anchors. *Bone Joint J*. 2019;101-B(12):1506-1511. doi:10.1302/0301-620X.101B12.BJJ-2019-0462.R2.
16. Matijakovich D, Solomon D, Benitez CL, Huang HH, Poeran J, Berger N, et al. Long-term follow-up of perianchor cyst formation after rotator cuff repair. *JSES Int*. 2021;5(5):863-868. doi:10.1016/j.jseint.2021.05.010.
17. Cole EW, Werner BC, Denard PJ. Perianchor cyst formation is similar between all-suture and conventional suture anchors used for arthroscopic rotator cuff repair in the same shoulder. *Arthrosc Sports Med Rehabil*. 2022;4(3):e949-e955. doi:10.1016/j.asmr.2022.01.007.
18. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al., editors. *Cochrane Handbook for Systematic Reviews of Interventions*. Version 6.5. Cochrane; 2024.

19. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. doi:10.1136/bmj.n71.
20. Rethlefsen ML, Kirtley S, Waffenschmidt S, Ayala AP, Moher D, Page MJ, et al. PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. *Syst Rev*. 2021;10(1):39. doi:10.1186/s13643-020-01542-z.
21. Crawford AE, Mussell EA, Ithurburn MP, Ostrander B, Brockington D, Arceo C, et al. Predictors of outcomes following double-row rotator cuff repair: an assessment of all-suture or solid medial row anchor utilization at a single high-volume institution. *JSES Rev Rep Tech*. 2026;6(2):100639. doi:10.1016/j.xrrt.2025.100639.
22. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898. doi:10.1136/bmj.l4898.
23. Sterne JAC, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919. doi:10.1136/bmj.i4919.
24. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3):177-188. doi:10.1016/0197-2456(86)90046-2.
25. Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557-560. doi:10.1136/bmj.327.7414.557.