A Review Paper

Outcomes of Arthroscopic Versus Open Rotator Cuff Repair: A Systematic Review of the Literature

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Abstract

Full-thickness rotator cuff tears are common. When symptomatic, they can affect quality of life. Surgical repair might improve patients' overall health.

We systematically reviewed postoperative outcomes in 10 studies comparing mini-open repair and all-arthroscopic repair techniques. Data regarding patient demographics, rotator cuff pathology, postoperative rehabilitation protocols, American Shoulder and Elbow Surgeons (ASES) scores, University of California Los Angeles (UCLA) scores, pain scores, and incidence of recurrent defects were extracted.

There were no statistically significant differences between groups within each study in terms of these data points. One study found decreased pain 6 months after surgery in the all-arthroscopic group versus the mini-open repair group.

This systematic literature review indicates there is no statistically significant difference in postoperative ASES, UCLA, or pain scores or incidence of recurrent rotator cuff tears in rotator cuffs repaired all-arthroscopically versus using the mini-open technique. However, there might be decreased short-term pain in patients who undergo arthroscopic repairs.

Rotator cuff injury has a profound effect on patients' quality of life and overall health. In a study of 5 common shoulder conditions, by Gartsman and colleagues,[1] patients with full-thickness reparable rotator cuff tears reported SF-36 (short form, 36 questions) Health Survey physical functioning, bodily pain, general health, vitality, social functioning, and mental health scores significantly worse than US general population norms. Surgery for rotator cuff pathology has been shown to improve overall health status as well as shoulder symptoms.[2,3] Full-thickness rotator cuff tears are fairly common, even in asymptomatic patients in the general population. Cadaver studies[4,5] have shown a 17% to 30% incidence of full-thickness rotator cuff tears. Studies on asymptomatic patients[6-8] have shown rotator cuff tear incidence of 20% to 54% in patients older than 60 years and 51% to 80% in patients older than 80 years.

There are 3 general categories of surgical repair of rotator cuff tears—open, mini-open, and arthroscopic. Regardless of surgical approach, the goals of rotator cuff repair, as explained by Neer,[9] are to preserve or carefully repair the deltoid origin; adequately decompress the subacromial space; obtain freely mobile muscle–tendon units through surgical release, as necessary; fix the tendon to the greater tuberosity; and prevent postoperative adhesions and subsequent stiffness without disrupting the repair by a closely monitored rehabilitation program. Since the first reported rotator cuff repair, by Codman[10] in 1911, open rotator cuff repair has produced good to excellent results in functional improvement (70% to 95%) and pain relief (85% to 100%) in numerous studies.[11-15] With the advent of arthroscopic technology and techniques, new surgical methods were sought to incorporate the advantages of decreased postoperative pain and quicker return to functionality associated with other arthroscopic procedures with the known capabilities of open techniques for repairing rotator cuff pathology. The result of such thinking was the mini-open technique, wherein the deltoid is split in line with its fibers without detachment from the acromion, and tendon repair is exacted with anchors, bone tunnels, or both.[16] This technique has shown results comparable to those of open procedures for repair of rotator cuff tears.[17-20]

With recent innovations and technologic advances of general arthroscopic instruments and rotator cuff repair-specific appliances, the trend has been toward all-arthroscopic repair of rotator cuff tears. The theoretical advantages of such a technique include decreased immediate postoperative pain, decreased surgical insult to deltoid, and decreased postoperative stiffness.[21] These effects could translate into quicker return to functionality and work and increased patient satisfaction. There has been some hesitation to switch to all-arthroscopic repairs, however, because of concerns about repair integrity, functional deterioration, and difficulty in reaching proficiency in this technique.[22-24]

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Table I. Patient Characteristics[a]

Study	Arthroscopic /Open (n/n)	Sex	Mean Age (y)	Mean Preoperative Symptom Duration (mo)	Preoperative Tear Size
Verma et al[34]	38/33	22M + 16F /23M + 10F	59.5/60.7	NR	2.5 cm / 2.8 cm
Severud et al[35]	35/29	21M + 14F / 18M + 11F	58.7/63.3	10.8/15.7	3 small, 23 medium, 9 large / 1 small, 10 medium, 18 large
Warner et al[36]	9/12	5M + 4F /8M + 4F	53/55	9/12	NR
Youm et al[37]	42/42	NR	57.9/60	NR	21 small, 9 medium, 12 large / 17 small, 23 medium, 2 large[b]
Ide et al[38]	50/50	41M + 9F /39M + 11F	57.5/57.1	8/6.4	5 small, 28 medium, 9 large, 8 massive / 2 small, 35 medium, 8 large, 5 massive
Sauerbrey et al[39]	28/26	16M + 12F /16M + 10F	56/57	NR	22 medium, 3 large, 3 massive / 17 medium, 6 large, 3 massive
Bishop et al[40]	40/ 32 (24 open, 8 mini-open)	72 (41F + 31M)	64/64	NR	3.0 cm / 2.6 cm
Liem et al[41]	19/19	16M + 3F /16M + 3F	61.9/62.1	10.6/9.6	3 small, 14 medium, 2 large / 1 small, 15 medium, 3 large
Kang et al[42]	65/63	NR	NR	NR	1.6 cm / 1.8 cm[c]
Weber[43]	29/151	NR	NR	NR	NR

Abbreviations: M, male; F, female; NR, not reported.
[a]Original investigators deemed all differences not statistically significant, except for preoperative tear size as noted by Youm et al[37] and Kang et al[42]. For specifics in calculation of preoperative tear size, consult original studies.
[b]Statistically significant difference between groups with respect to number of medium and large tears ($P = .002$).
[c]Mean tear size in mini-open group slightly larger than in arthroscopic group ($P = .01$).

Studies independently examining the long-term success of arthroscopically repaired rotator cuff injuries in terms of cuff integrity and clinical outcomes[25-30] have shown success rates comparable to those of mini-open and open procedures, but there is a lack of randomized, controlled trials comparing these 2 approaches.

However, multiple retrospective studies have compared the effectiveness of all-arthroscopic rotator cuff repair and mini-open rotator cuff repair. We decided to systematically review the literature to determine if all-arthroscopic rotator cuff repair was equivalent to mini-open rotator cuff repair with respect to postoperative American Shoulder and Elbow Surgeons (ASES) and University of California Los Angeles (UCLA) scores, pain, and rotator cuff integrity.

Methods

We searched the literature on PubMed (using the phrase *arthroscopic open rotator cuff repair*); on Ovid MEDLINE (1950 through week 4 of July 2007) and Cochrane Database of Systematic Reviews and Central Register of Controlled Trials (using the phrases *open rotator cuff repair* and *arthroscopic rotator cuff repair*); and on EBSCO Host (using the phrases *open rotator cuff repair* and *arthroscopic rotator cuff repair*). We did not specify any exclusions. Our search for these phrases returned 139, 65 and 87, and 18 and 32 manuscripts, respectively. We reviewed the abstracts of the manuscripts for mention of studies comparing all-arthroscopic and mini-open or arthroscopically assisted rotator cuff repair surgeries. Thirteen such manuscripts were found, and these were reviewed manually. The references for each of these 13 studies also were examined for other relevant papers. Two case series, by Buess and colleagues[31] and Kim and colleagues,[32] immediately were excluded. The paper by MacDermid and colleagues[33] was excluded because it was a protocol for a randomized trial comparing all-arthroscopic and mini-open repairs. Included studies were prospective or retrospective comparative studies; studies comparing arthroscopic and mini-open rotator cuff repair; and studies measuring outcome based on postoperative ASES or UCLA scores, pain, or rotator cuff integrity. Ten studies[34-43] were identified for further review.

Each of these 10 studies was systematically reviewed with a worksheet (from Spindler and colleagues[44]) on reading and reviewing orthopedic literature. Article title, author name, journal title, hypothesis, study type, study design, and results were recorded. In addition, the articles were evaluated for bias sources, validity of their statistical analyses, and other details pertaining to study design to identify the level of evidence. We included level III or higher studies, but no further attempt was made to rank study quality.

From these 10 studies, data concerning patient demographics, operative techniques, postoperative rehabilitation regimens, postoperative ASES and UCLA scores, pain scores, and number of recurrent rotator cuff tears were extracted and then arranged into tables for further analysis.

Results

Patient Demographics

As seen in Table I, there were no statistically significant differences between groups of patients within each of the 10 studies in terms of number of patients in the all-arthroscopic or mini-open repair groups, sex, mean age, mean preoperative duration of symptoms, or tear size, where reported, with the exception of 2 studies. Youm

Table II. Exclusion Criteria and Concomitant Procedures

Study	Rotator Cuff Tendon Involved	Exclusion Criteria	Concomitant Surgical Procedures
Verma et al[34]	Subscapularis excluded	Revision procedures, subscapularis tears, partial or irreparable tears, or open repairs	Arthroscopic: 4 distal clavicle excisions, repair of 5 SLAP I and 1 SLAP II lesions, 3 biceps tenotomies Mini-open: 4 distal clavicle excisions, repair of 6 SLAP I and 3 SLAP II lesions, 1 biceps tenotomy, 2 biceps tenodesis procedures
Severud et al[35]	NR	Other significant intra-articular pathology (SLAP lesions or glenohumeral arthrosis), previous rotator cuff surgery, massive (>5 cm) rotator cuff tears, neurologic disorders (brachial plexopathy or suprascapular neuropathy)	Arthroscopic: 4 acromioclavicular joints coplaned Mini-open: 11 acromioclavicular joints coplaned
Warner et al[36]	Supraspinatus only	Prior surgery, extension of tendon tear into subscapularis or infraspinatus, concomitant stiffness	NR
Youm et al[37]	NR (full-thickness tears not specified)	Previous rotator cuff surgery, massive (>5 cm) rotator cuff tears, worker's compensation patients, and patients with loss of passive range of motion, acromioclavicular joint pathology, or intra-articular lesions	NR
Ide et al[38]	Subscapularis excluded	Irreparable rotator cuff tear reconstructions, subscapularis tears, prior shoulder surgery, worker's compensation patients, or other significant intra-articular pathology	NR
Sauerbrey et al[39]	NR	Follow-up of less than 1 year	NR
Bishop et al[40]	NR	Disorders such as glenohumeral arthritis, fracture, osteonecrosis, or labral pathology	NR
Liem et al[41]	Supraspinatus only	Previous surgery, major trauma with dislocation or grade 3 atrophy of supraspinatus	Arthroscopic: 6 acromioclavicular joint resections, 5 biceps tenotomies Mini-open: 4 acromioclavicular joint resections, 2 biceps tenodesis procedures, 2 biceps tenotomies
Kang et al[42]	NR	Large or massive rotator cuff tears, prior surgery for rotator cuff pathology, concomitant lesion of proximal long head tendon of biceps muscle, or concomitant distal clavicle excision	Arthroscopic: 10 limited synovectomies, 13 capsular releases Mini-open: 12 limited synovectomies, 14 capsular releases
Weber[43]	NR	NR	NR

Abbreviations: NR, not reported, SLAP, superior labrum anterior-posterior.

and colleagues[37] found a statistically significant difference ($P = .002$) in number of medium and large tears between the groups, with more medium tears in the mini-open group and more large tears in the all-arthroscopic group, and Kang and colleagues[42] reported that mean tear size was significantly ($P = .01$) larger in the mini-open group.

Rotator Cuff Pathology

All the studies, except that by Weber,[43] listed specific inclusion and exclusion criteria. These criteria varied by tear size, tendons involved, and intra-articular pathology requiring concomitant procedures (Table II). All but 4 studies[37,41-43] indicated that subjects had full-thickness tears of at least 1 rotator cuff tendons. Verma and colleagues[34] and Ide and colleagues[38] excluded rotator cuff tears that involved the subscapularis tendon. Warner and colleagues[36] and Liem and colleagues[41] included only patients with supraspinatus tendon tears. Verma and colleagues, Liem and colleagues, and Kang and colleagues[42] detailed number and type of concomitant surgical procedures for pathology in addition to rotator cuff injury performed within each group at time of rotator cuff repair. Severud and colleagues[35] coplaned only the acromioclavicular joint but excluded "significant intra-articular pathology." The other 6 studies[36-40,43] did not report any other procedures for additional shoulder pathology, and some specifically excluded such patients. Youm and colleagues[37] excluded patients with acromioclavicular joint pathology or intra-articular lesions; Ide and colleagues excluded patients with "other significant intra-articular pathology;" and Bishop and colleagues[40] excluded patients with glenohumeral arthritis, fracture, osteonecrosis, or labral pathology.

Table III. Postoperative Rehabilitation Regimens

Study	Similar Protocol Between Groups	Immobilization	Time to/Length of Passive ROM	Time to Active ROM (wk)	Time to Strength/ Weight-Bearing
Verma et al[34]	Yes[a]	Sling	First 6 weeks	6	12 weeks
Severud et al[35]	Yes	Sling	Immediately after surgery	4	3 months
Warner et al[36]	Yes	Sling	First 4 weeks	4	12 weeks
Youm et al[37]	Yes[b]	Sling	Immediately after surgery	4-6	NR
Ide et al[38]	Yes	Sling & abduction pillow	Day 1 with continuous passive motion machine	2-4	6-9 weeks[d]
Sauerbrey et al[39]	Yes[c]	Sling for small/medium tears /massive tears Abduction pillow for large	First 6 weeks	6	6 weeks (Therabands)
Bishop et al[40]	Yes	Sling	First 6 weeks	6	NR[e]
Liem et al[41]	Yes	Sling for 48 hours, then abduction pillow for 3 weeks	First 6 weeks	6	9 weeks
Kang et al[42]	Yes	Sling	Day after surgery	6	6-8 weeks (isometric)
Weber[43]	NR	—	—	—	—

Abbreviations: NR, not reported; ROM, range of motion.
[a]Protocol varied by surgeon but was identical between groups of each surgeon.
[b]Size of rotator cuff tear, security of repair, and intraoperative assessment of repair determined postoperative therapy regimen.
[c]Protocol differences dependent on tear size, not repair method.
[d]Begun when patient could perform active forward elevation above shoulder level.
[e]Progression to resistive strengthening after full active motion was instituted.

Surgical Technique

Open Repair. Mini-open or open rotator cuff repair was performed primarily by transosseous tunnels in 5 studies: Severud and colleagues,[35] Warner and colleagues,[36] Sauerbrey and colleagues,[39] Bishop and colleagues,[40] and Kang and colleagues.[42] Youm and colleagues[37] and Liem and colleagues[41] used suture anchors, and Verma and colleagues[34] used suture anchors, transosseous tunnels, or both. Youm and colleagues used transosseous tunnels in place of suture anchors when the anchors did not hold well in bone. Ide and colleagues[38] used single-row suture anchors in a majority of cases but transosseous tunnels in 3 cases. Weber[43] did not specify repair technique. Mason-Allen stitches were used in the repairs performed by Warner and colleagues and Bishop and colleagues, and modified Mason-Allen stitches were used by Liem and colleagues and Kang and colleagues. Marginal convergence was done, as needed, by Youm and colleagues and Sauerbrey and colleagues.

Arthroscopic Repair. All 10 studies, except the study by Weber,[43] used suture anchors in arthroscopic rotator cuff repairs. Those surgeries, performed by Warner and colleagues,[36] Ide and colleagues,[38] Bishop and colleagues,[40] Liem and colleagues,[41] and Kang and colleagues,[42] used single-row anchors. The other 4 studies[34,35,37,39] did not specify single- or double-row anchors. Marginal convergence was used, as needed, by Youm and colleagues,[37] Ide and colleagues, Sauerbrey and colleagues,[39] Liem and colleagues, and Kang and colleagues. Bishop and colleagues occasionally used medial fixation with a tendon-transfixing device, Cufftack (Mitek Worldwide, Westwood, Massachusetts) or Suretac (Smith & Nephew, Inc., Andover, Massachusetts). The tendon in the study by Liem and colleagues was repaired with a Mason-Allen technique modified for arthroscopy.

Postoperative Rehabilitation Protocols

All the articles, minus the abstract by Weber,[43] outlined postoperative rehabilitation regimens used (Table III). All the authors reported using similar protocols for the arthroscopically repaired and mini-open repaired groups. Verma and colleagues[34] included patients of 5 attending surgeons and reported that postoperative protocols varied by surgeon but were not changed on the basis of repair technique used. Youm and colleagues[37] reported that postoperative regimens were based on rotator cuff tear size, repair security, and intraoperative assessment of repair but did not depend on repair type (arthroscopic vs mini-open). Sauerbrey and colleagues[39] also reported that rehabilitation protocols were based on preoperative tear size and not repair method. All studies included immediate postoperative immobilization with a sling and at least 2 weeks of passive range-of-motion activities, with most then starting active range of motion 4 to 6 weeks after surgery. Strength training exercises or weight-bearing was then introduced between 6 weeks and 12 weeks (3 months) after surgery.

Postoperative Outcome Measurements

Postoperative ASES Scores. Five studies[34,35,37,39,40] reported postoperative ASES scores by repair method (Table IV). ASES scores for the all-arthroscopic groups in these 5 studies were 94.6, 91.7, 91.1, 86, and 84 respectively, and ASES scores for the mini-open groups were 95.1, 90, 90.2, 89, and 85, respectively. No score reached statistical significance ($P>.05$). The other studies did not report preoperative or postoperative ASES scores.

Postoperative UCLA Scores. Four studies, by Severud and colleagues,[35] Youm and colleagues,[37] Ide and colleagues,[38] and Weber,[43] reported postoperative UCLA scores by repair method (Table V). UCLA scores for

Table IV. American Shoulder and Elbow Surgeons (ASES) Score as Outcome Measurement

Study	Postoperative Scores	*P*	Statistically Significant
Verma et al[34]	Arthroscopic, 94.6; mini-open, 95.1	>.05	No
Severud et al[35]	Arthroscopic, 91.7; mini-open, 90	>.05	No
Warner et al[36]	NR	—	—
Youm et al[37]	Arthroscopic, 91.1; mini-open, 90.2	>.05	No
Ide et al[38]	NR	—	—
Sauerbrey et al[39]	Arthroscopic, 86; mini-open, 89	.333	No
Bishop et al[40]	Arthroscopic, 84; mini-open, 85	.73	No
Liem et al[41]	NR	—	—
Kang et al[42]	NR	—	—
Weber[43]	NR	—	—

Abbreviation: NR, not reported.

Table V. University of California Los Angeles (UCLA) Score as Outcome Measurement

Study	Postoperative Scores	*P*	Statistically Significant
Verma et al[34]	NR	—	—
Severud et al[35]	All-arthroscopic, 32.6; mini-open, 31.4	>.05	No
Warner et al[36]	NR	—	—
Youm et al[37]	Arthroscopic, 33.2; mini-open, 32.3	>.05	No
Ide et al[38]	Arthroscopic, 32; mini-open, 31.6	>.05	No
Sauerbrey et al[39]	NR	—	—
Bishop et al[40]	NR	—	—
Liem et al[41]	NR	—	—
Kang et al[42]	NR	—	—
Weber[43]	Arthroscopic, 31.4; mini-open, 30.2	>.05	No

Abbreviation: NR, not reported.

the all-arthroscopic groups in these 4 studies were 32.6, 33.2, 32, and 31.4, respectively, and UCLA scores for the mini-open groups were 31.4, 32.3, 31.6, and 30.2, respectively. There was no statistically significant difference between repair techniques ($P>.05$) within each study. The other studies did not report preoperative or postoperative UCLA scores.

Other. Warner and colleagues,[36] Liem and colleagues,[41] and Kang and colleagues[42] did not report ASES or UCLA scores as outcome measurements. Warner and colleagues and Kang and colleagues used the simple shoulder test as an outcome measurement, and Liem and colleagues reported using Constant scores. Additional functional outcome measurements included L'Insalata scores (used by Verma and colleagues[34]), Japanese Orthopedic Association (JOA) scores (Ide and colleagues[38]), Constant scores (Bishop and colleagues[40]), and Disabilities of the Arm, Shoulder, and Hand (DASH) scores (Kang and colleagues). No measurement demonstrated statistically significant differences in outcome between the all-arthroscopic and mini-open repair groups within each study, but the details of these studies are not given here.

Postoperative Pain Scores

All but 4 studies[35,37,41,42] provided data on postoperative pain measurements between groups. Verma and colleagues,[34] Bishop and colleagues,[40] and Kang and colleagues[42] used the visual analog scale (VAS) for pain; Kang and colleagues measured pain 3 months and 6 months after surgery. Warner and colleagues[36] reported measurements on an identical, 0-to-10 scale but did not refer to it as VAS. For these 4 studies (Table VI), mean postoperative pain scores for the all-arthroscopic group were 0.7, 1.5, 2.7 (3 months) and 1.9 (6 months), and 0 (median), respectively; for the mini-open group, scores were 0.4, 1.1, 3 (3 months) and 2.5 (6 months), and 0 (median). The 6-month postoperative pain score reported by Kang and colleagues reached statistical significance ($P = .03$) for decreased pain in the all-arthroscopic group compared with the mini-open group. No other measure of postoperative pain was statistically significant. Ide and colleagues[38] used the JOA pain scale. Postoperative pain was 27.7 for the arthroscopic group and 26.4 for the mini-open group—a difference that was not statistically significant ($P>.05$). Sauerbrey and colleagues[39] used a 10-point VAS to measure pain at rest, during activities of daily living, and during strenuous activity. These 3 responses were totaled, and pain was reported on a 0-to-30 scale. Mean postoperative pain was 26 for the all-arthroscopic group and 27 for the mini-open group. Statistical comparisons were not made between treatment groups, only within groups. Postoperative pain was significantly ($P<.05$) lower than preoperative pain both for the arthroscopic group and the mini-open group.

Table VI. Pain as Outcome Measurement

Study	Pain Scale	Mean Postoperative Pain Measurements	*P*	Statistically Significant
Verma et al[34]	VAS	Arthroscopic, 0.7; mini-open, 0.4	>.05	No
Severud et al[35]	NR	—	—	—
Warner et al[36]	Pain scale (0-10)[a]	Arthroscopic, 0[d]; mini-open, 0	.92	No
Youm et al[37]	NR	—	—	—
Ide et al[38]	JOA pain scale (0-30)[b]	Arthroscopic, 27.7; mini-open, 26.4	>.05	No
Sauerbrey et al[39]	Pain scale (0-30)[c]	Arthroscopic, 26; mini-open, 27	—	Comparison within, not between, groups
Bishop et al[40]	VAS	Arthroscopic, 1.5; mini-open, 1.1	.41	No
Liem et al[41]	NR	—	—	—
Kang et al[42]	VAS 3 months after surgery	Arthroscopic, 2.7; mini-open, 3		
	VAS 6 months after surgery	Arthroscopic, 1.9; mini-open, 2.5	>.05 .03	No Yes
Weber[43]	NR	—	—	—

Abbreviations: VAS, visual analog scale; NR, not reported; JOA, Japanese Orthopedic Association.
[a]0 = best, 10 = worst.
[b]0 = totally incapacitating pain; 5 = severe pain (frequent night pain); 10 = moderate and tolerable pain (occasional night pain); 20 = minimal pain in activities of daily living; 25 = tenderness or minimal pain in sports or heavy labor; 30 = no pain.
[c]On 10-point VAS (0 = severe pain, 10 = no pain), patients rated pain (1) at rest, (2) during activities of daily living, and (3) during strenuous activity; these 3 scores were then summed.
[d]Pain measurements reported as medians.

Table VII. Incidence of Recurrent Postoperative Rotator Cuff Defects

Study	Defects/Repairs (n/n) Arthroscopic	Defects/Repairs (n/n) Mini-Open	Imaging Used to Assess Postoperative Integrity	Follow-Up Duration (Mean, Except Where Indicated)	*P*	Significant
Verma et al[34]	9/38	9/33	Ultrasound	2 years minimum	>.05	No
Severud et al[35]	NR/35	NR/29	—	Arthroscopic, 38.4 months; mini-open, 52 months	—	—
Warner et al[36]	NR/9	NR/12	—	Arthroscopic, 44 months; mini-open, 55 months	—	—
Youm et al[37]	1/42	3/42	NR	Arthroscopic, 35.2 months; mini-open, 37.6 months	NR	—
Ide et al[38]	1/50	NR/50	MRI	49 months	—	—
Sauerbrey et al[39]	NR/28	NR/26	—	Arthroscopic, 19 months; mini-open, 33 months	—	—
Bishop et al[40]	Total: 19/40	10/32	MRI	1 year minimum	>.05	No
	<3 cm: 3/19	5/19			>.05	No
	>3 cm: 16/21	5/13			.036	Yes
Liem et al[41]	6/19	7/19	MRI	Arthroscopic, 25 months; mini-open, 17.6 months	>.05	No
Weber[43]	NR[1]/29	NR/151	—	Arthroscopic, 36.3 months; mini-open, 47.8 months	—	—
Kang et al[42]	NR/65	NR/63	—	6 months minimum	—	—

Abbreviations: NR, not reported; MRI, magnetic resonance imaging.
[a]Weber[43] noted 2 manipulations and 2 reoperations for failed repair in open group (2%). In arthroscopic group, 4 patients had loose anchors with 2 failed repairs (4 total procedures) with reoperation rate of 14% ($P<.01$). Significance level is for reoperation rate, and not only for recurrent rotator cuff defects.

Recurrent Rotator Cuff Defects

Verma and colleagues,[34] Bishop and colleagues,[40] and Liem and colleagues[41] reported on the number of recurrent rotator cuff defects among their study groups (Table VII). Verma and colleagues used ultrasound to assess the integrity of the rotator cuff at a minimum of 2 years after surgery. There were 9 recurrent tears out of 38 arthroscopic repairs and 9 recurrent tears out of 33 mini-open repairs—not statistically significant ($P>.05$). Bishop and colleagues and Liem and colleagues both used magnetic resonance imaging (MRI) after surgery to assess for recurrence of rotator cuff tears. Bishop and colleagues noted 19 tears out of 40 arthroscopic repairs and 10 defects out of 32 mini-open repairs after at least 1 year. No statistically significant difference was found in the incidence of tears between groups ($P>.05$). When comparing small (<3 cm) versus large (>3 cm) rotator cuff tears, however, they found a statistically significant ($P = .036$) increase in recurrent defects in large tears repaired arthroscopically versus with open techniques. Liem and colleagues noted 6 recurrent defects out of 19 arthroscopic repairs and 7 tears out of 19 mini-open repairs at means of 25 months (arthroscopic group) and 17.6 months (mini-open group). This difference was not statistically significant ($P>.05$). Youm and colleagues[37] reported 1 recurrent defect out of 42 arthroscopic repairs and 3 recurrent defects out of 42 mini-open repairs, but information was not provided as to imaging modality used to assess for rotator cuff integrity, and statistical significance was not reported. Ide and colleagues[38] reported that 1 arthroscopic patient, who had severe pain during rehabilitation 6 weeks after surgery, had rotator cuff tear recurrence identified by MRI, but the imaging for other patients, if done, was not mentioned. Weber[43] noted 2 failed repairs out of 29 arthroscopic procedures and 2 failed repairs among the 151 patients in the open group, but there was no mention of a statistical com-

parison of incidence of recurrent defects between groups. Statistical analysis, performed for reoperation rate, showed a significantly ($P<.01$) higher percentage of arthroscopic patients requiring reoperation compared with patients in the open group. Four patients in the arthroscopic group had loose anchors that needed repair.

Discussion

In systematically reviewing the literature comparing all-arthroscopic rotator cuff repair with mini-open rotator cuff repair, we found evidence supporting our hypothesis that these 2 surgical methods for treating rotator cuff tears were equivalent in postoperative ASES and UCLA scores, pain, and integrity of repaired rotator cuff.

In a study of rotator cuff surgery patients' satisfaction with outcome, O'Holleran and colleagues[45] noted that satisfaction was based on subjective measures of symptoms and function. Decreased satisfaction was noted in patients who had pain, functional difficulty, or work disability. Although work disability was not specifically addressed in any of the studies we reviewed, groups of patients had equivalent function as assessed by ASES and UCLA scores and symptoms as measured by postoperative pain scores, regardless of surgical method used.

In fact, Kang and colleagues[42] found reduced VAS-measured postoperative pain at 6 months in patients with arthroscopically repaired rotator cuff tears as compared with patients who underwent mini-open repair. None of the other studies reported postoperative pain assessments within such a short time after surgery. Given the purported benefits of decreased postoperative pain and quicker return to functionality with other arthroscopic procedures, further study to validate these results in rotator cuff repair would be helpful in being able to recommend this surgical approach to patients on the basis of decreased postoperative pain.

Another potential advantage of arthroscopic rotator cuff repair is shorter hospital stay. Weber[43] noted a significantly ($P<.01$) decreased morbidity with arthroscopic procedures that allowed 94% of them (vs only 28% of mini-open procedures) to be performed on an outpatient basis. Assessing this feature of arthroscopic repair might further validate it as a viable alternative to more invasive methods.

Long-term integrity of repair also is important to patients and their physicians. Despite published concerns regarding reliability of arthroscopy in repairing rotator cuff tears,[22,23] our review of studies comparing all-arthroscopic methods to mini-open techniques in entire study populations (small and large tears) showed no difference in incidence of recurrent tears 1 to 2 years after surgery. Although some studies have shown excellent structural and functional outcomes many years after arthroscopic rotator cuff repair,[26,29] none of the studies we examined had follow-up periods this extensive. Additional study into the long-term integrity of arthroscopically repaired rotator cuffs compared with open and mini-open techniques in similar groups of patients could provide objective evidence as to the durability of arthroscopic rotator cuff repairs.

To our knowledge, no randomized, controlled trials have compared these 2 methods for surgically repairing rotator cuff tears. Warner and colleagues[36] reported they initially intended their study to be a randomized, prospective study, but recruitment was impossible, as most patients preferred one approach over the other. Thus, our systematic review has the inherent weaknesses of the retrospective and prospective comparative studies included in it.

As patients were not randomized in the studies we reviewed, selection bias was potentially present in all of them. This was most apparent as surgeons switched from mini-open repair to all-arthroscopic repair. Kang and colleagues[42] noted that, during the transition, the decision to perform arthroscopic repair or mini-open repair was based on rotator cuff mobility. When the tendon could be easily reduced to the insertion area of the greater tuberosity, an arthroscopic repair was performed. It was their study, in fact, that found a statistically significant difference between mean tear sizes in the 2 groups (larger mean tear size in mini-open group). This finding could have influenced their results and findings of decreased pain at 3 months (SF-36 Health Survey) and 6 months (VAS) in the all-arthroscopic group.

Bishop and colleagues[40] compared open and mini-open repairs with all-arthroscopic repairs and noted a relatively high recurrence rate for tears (47% in arthroscopic group, 31% in open group) and a statistically significant ($P = .036$) retear incidence in patients with preoperative tears larger than 3 cm (16 of 21 patients in arthroscopic group, 5 of 13 patients in open group). In another example of selection bias, they felt this relatively high recurrence rate might have resulted from the temptation to use an arthroscopic technique on larger, less reparable tears because of decreased morbidity with this type of repair. Some of the arthroscopic repairs in their study were performed with medial fixation using the Cufftack and Suretac tendon-transfixing devices, which are no longer used because of their high failure rate. Thus, the high rotator cuff retear rate found with arthroscopic repair of large tears in this study cannot be attributed entirely to alleged deficiencies of arthroscopic repair but might have resulted from the medial fixation technique or hardware used.

All the studies except those by Youm and colleagues[37] and Kang and colleagues[42] had comparable groups of patients—with respect to number of patients in each group, sex, mean age, mean preoperative duration of symptoms, and preoperative tear size—to eliminate or reduce confounding. It is difficult to formulate valid conclusions about postoperative outcomes favoring one approach over another when study groups are not

comparable. This is especially true for rotator cuff tear sizes. Larger rotator cuff tears have functional outcomes lower than those of small or medium-sized tears.[17]

There are challenges in accurately classifying rotator cuff tears arthroscopically. A study of classification of rotator cuff tears[46] showed that there is little interobserver reliability among experienced shoulder surgeons using current rotator cuff classification systems. Although we did not compare outcomes of rotator cuff repair based on tear size in the present study, this difficulty could have led to inaccurate categorization of patients within each of the studies reviewed. However, the effect on the present review is likely minimal—in most of the reviewed articles, surgeries were performed by one surgeon, who likely had a similar measurement and classification system for the study duration—but might make comparisons between studies less accurate.

With the exception of the study by Ide and colleagues,[38] in which the examiner was blinded to operative procedure at follow-up visits, none of the other studies reported blinding techniques used, if any. As most of these studies were retrospective, it is doubtful that blinding took place. Blinding reduces the likelihood of introduction of measurement bias and would be valuable for studies assessing the effectiveness of 2 different surgical procedures addressing the same pathology.

There were also many between-studies variations in specific inclusion and exclusion criteria. Some studies included patients who had undergone other procedures for intra-articular pathology at the time of their rotator cuff repair, whereas others did not. Some excluded large or massive rotator cuff tears, and others did not. Some even specified which tendons could be torn, and others did not. Despite these differences in study design, there were no statistically significant differences in preoperative characteristics between groups within each study, except for mean tear size in 2 studies, as already explained. Further prospective study into these 2 operative techniques should exclude intra-articular pathology beyond tear of 1 or more of the rotator cuff tendons in order to decrease potential confounding.

Operative technique also varied between studies. Although it is not possible to perform identical fixations with open and arthroscopic techniques, there were differences even between the method of open and arthroscopic repairs from one study to another. This situation makes comparison between studies somewhat challenging, but, again, as all the studies reported no statistically significant difference in postoperative ASES scores, UCLA scores, or recurrence rates and most found no difference in pain scores, the effect of this variability is likely negligible.

Several conclusions can be made from this systematic review. First, in trials comparing arthroscopic and mini-open rotator cuff repair, no statistically significant differences were found in outcomes of postoperative ASES or UCLA scores. Second, these same trials likewise did not demonstrate a statistically significant difference in rate of recurrent rotator cuff tears between operative approaches. Third, postoperative assessment of pain was not statistically different between groups 1 year or more after surgery. Last, Kang and colleagues[42] demonstrated a statistically significant difference in postoperative pain favoring the arthroscopic group 6 months after surgery, though this finding must be tempered with the knowledge that patient groups in this study were not comparable in terms of tear size. With the types of studies and data available, there is not enough information from comparative studies to direct clinical practice toward or away from all-arthroscopic repair of rotator cuff tears. Further studies, including randomized, controlled trials, studies assessing short-term pain outcomes, and trials comparing long-term integrity, need to be completed before more definitive recommendations can be made.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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