Arthroscopic Versus Open Lateral Release for the Treatment of Lateral Epicondylitis: A Prospective Randomized Controlled Trial

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Purpose: The purpose of this randomized clinical trial was to determine whether quality of life and function, as measured using subjective questionnaires and clinical assessment, are different after open versus arthroscopic debridement of the pathologic extensor carpi radialis brevis origin in the treatment of lateral epicondylitis at 1 year postoperatively. **Methods:** Patients older than 16 years with a minimum of 6 months of nonoperative management for lateral epicondylitis were recruited into this prospective, single-blinded randomized clinical trial. Patients were randomized intraoperatively to undergo open or arthroscopic release. Scores on the Disabilities of the Arm, Shoulder and Hand (DASH) outcome measure; visual analog scale (VAS); and Patient-Rated Tennis Elbow Evaluation (PRTEE) were recorded preoperatively and 3, 6, and 12 months postoperatively. Grip strength was assessed by an independent assessor. All patients followed the same physiotherapy regimen. **Results:** Between 2002 and 2014, we randomized 37 patients to the open technique and 38 to the arthroscopic technique. Both groups improved significantly from preoperatively to 12 months postoperatively ($P < .001$). There were no significant differences between the 2 groups when comparing the DASH score, VAS score, PRTEE score, or grip strength at any time point. The only significant difference between study groups was that the arthroscopic technique resulted in a longer surgery time: 34.0 minutes (standard error of the mean, 2.9 minutes) versus 22.5 minutes (standard error of the mean, 1.3 minutes) ($P = .005$). **Conclusions:** Comparing the open versus arthroscopic technique in the surgical management of lateral epicondylitis through a randomized clinical trial, we determined that there was no difference between the 2 operative modalities when examining the DASH score, VAS score, PRTEE score, grip strength, or complication rate at 12 months postoperatively. A shorter operative time coupled with potentially less setup time may favor open release. **Level of Evidence:** Level II, lower-quality randomized trial.

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Lateral epicondylitis, or "tennis elbow," is the most commonly diagnosed elbow disorder, affecting 1% to 3% of the population in the United States[1-3] and primarily affecting persons aged between 30 and 55 years.[4] It is described to be a degenerative process due to microtrauma, with the extensor carpi radialis brevis (ECRB) particularly affected.[5-8] Most patients, estimated between 79% and 95%, have complete relief with conservative treatment (e.g., rest, ice, bracing, nonsteroidal anti-inflammatory drugs, eccentric exercise, ultrasound, friction massage, stretching, acupuncture, and injections) at 1 year, with some having relief at 1.5 years.[9-11] Operative treatment is sometimes considered if symptoms persist after 6 to 12 months of conservative treatment.

The first surgical approach, open debridement and release, was reported in 1979 with a rate of improvement of 97.7% and only 2 failures among 88 procedures.[12] Arthroscopic release was introduced in the early 1990s, with the advantages of being less invasive and potentially reducing operative morbidity having been cited.[13] The arthroscopic approach also allows for clear identification of intra-articular pathology. Moreover, it was thought

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The authors report the following potential conflict of interest or source of funding: The Alexander Gibson Chair Fund and the Pan Am Clinic Foundation provided funding for this study. T.C. receives support from University of Manitoba Alexander Gibson Fund. S.M. receives support from University of Manitoba Alexander Gibson Fund. J.L. receives support from University of Manitoba Alexander Gibson Fund. Y.Z. receives support from University of Manitoba Alexander Gibson Fund. J.D. receives support from University of Manitoba Alexander Gibson Fund. P.M. receives support from University of Manitoba Alexander Gibson Fund. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received November 7, 2017; accepted July 5, 2018.

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0749-8063/171363/$36.00

https://doi.org/10.1016/j.arthro.2018.07.008

that the rehabilitation period would be shorter and recovery to normal activity would be expedited. A small number of retrospective and prospective case series have been conducted to evaluate open and arthroscopic approaches, showing improvement in patients overall. However, the strengths and drawbacks of each approach vary between studies, and when our study was launched in 2005, no randomized clinical trials directly comparing open versus arthroscopic release had been conducted. Thus, undertaking a higher-level research design (i.e., randomized clinical trial) had merit.

The purpose of this randomized clinical trial was to determine whether quality of life and function, as measured using subjective questionnaires and clinical assessment, are different after open versus arthroscopic debridement of the pathologic ECRB origin in the treatment of lateral epicondylitis at 1 year postoperatively. We hypothesized that there would be no difference between techniques in these patient-related outcomes. We also hypothesized that the duration of the arthroscopic technique would be significantly greater than the open technique.

Methods

Study Design

We performed a single-blinded, prospective, randomized clinical trial with 2 parallel groups. This study was approved by the institutional research ethics board (B2005-027, University of Manitoba Biomedical Research Ethics Board, Winnipeg, Canada).

Participants

Patients were identified by 1 of 3 participating surgeons (T.C., J.D., P.M.) on the basis of surgical consultation and then screened for inclusion by a research assistant (S.M.). If deemed eligible, patients were approached by the research assistant, who proceeded through the consenting process. The study group was comprised of male and female patients older than 16 years with a confirmed diagnosis of lateral epicondylitis based on tenderness at the lateral epicondyle, pain with resisted wrist extension, full range of motion at the elbow and wrist, and no neurologic symptoms. They had to have undergone a minimum of 6 months of failed conservative treatment including 1 corticosteroid injection, with negative findings for a fracture on radiographs. A minimum of 6 months of conservative treatment was chosen because this is the typical duration after which the primary physician in the involved center would request a surgical consultation if little to no progress had been made using conservative treatment. Patients were excluded if they underwent previous surgical treatment for lateral epicondylitis. They also would have been excluded if they had another medical condition that would affect quality of life (e.g., rheumatoid arthritis); however, this circumstance did not arise.

Outcome Measures

The primary outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) outcome measure.[14] The DASH questionnaire is a widely used region-specific questionnaire that has shown reliability, validity, and responsiveness in both proximal and distal disorders of the upper extremity.[15] Pain and patient quality of life were assessed using a 5-question visual analog scale (VAS) questionnaire. Patient-reported function was evaluated using the Patient-Rated Tennis Elbow Evaluation (PRTEE), a validated disease-specific measure composed of 5 questions on pain and 10 on function, using a series of 10-point Likert scales.[16] Pain-free grip strength was measured using a Chattanooga baseline hydraulic hand dynamometer (DJO Global, Mississauga, Canada) with the elbow at 90° and in full extension. Surgical times and complication rates were also noted. Clinical evaluations were conducted by a blinded assessor (S.M.) preoperatively and at 3, 6, and 12 months postoperatively. Blinding of the assessor was achieved by the patients wearing long-sleeved clothing or being asked to don a sheath to cover the incision site before the assessor entered the room.

Study Protocol

Patients who agreed to participate and signed an informed consent form were randomized at the time of surgery to 1 of 2 study groups: (1) open release group (Nirschl technique)[12] and (2) arthroscopic lateral release group.[17] Once eligibility was confirmed intraoperatively, a pre-generated opaque, sealed envelope was opened, allocating the patient to 1 of the 2 surgical treatments. Computer-generated block randomization was conducted to ensure that the study groups remained balanced. Patients had no input into their preference of surgical approach for the procedure. Moreover, it should be noted that no steroid or biologic (i.e., platelet-rich plasma) injections were used in conjunction with either procedure.

Open Release. Patients randomized to the open group were positioned supine on the operating table with the affected arm resting on a hand table. The limb was prepared and draped free in the usual fashion. A 7.5-cm incision was made from 2.5 cm proximal to the lateral epicondyle to 5 cm distal to it, curving gently anteriorly. The deep fascia was then divided and retracted. Just deep to the fascia lay the extensor carpi radialis longus (ECRL) and the extensor aponeurosis. By use of scissors, the ECRL was dissected from the aponeurosis proximally to the lateral epicondyle and distally to the level of the radial head. Anterior retraction on the ECRL showed the ECRB and gross pathologic alteration in this structure.

The origin of the ECRB was incised and released by sharp dissection off the bone. Normally, this encompassed approximately 75% of the tendinous origin. The undersurface of the tendon was evaluated for tears. The extensor aponeurosis was also evaluated at this time. All pathologic tissue was removed, and a small opening was made in the lateral capsule to expose the lateral portion of the joint. A small area of the lateral condyle was then decorticated to ensure adequate blood supply and healing potential. Deep closure involved repairing the interval between the ECRL and aponeurosis using a running No. 0 chromic suture. The skin was closed with buried No. 3-0 Vicryl sutures (Ethicon, Somerville, NJ) and a running subcuticular No. 4-0 Monocryl layer (Ethicon), followed by Steri-Strips (3M, St Paul, MN).

Arthroscopic Lateral Release. Patients randomized to the arthroscopic group were placed prone on the operating table with the affected elbow at 90° of flexion. The limb was prepared and draped free in the usual operative manner. The elbow joint was distended with saline solution (30 mL) through the soft spot, that is, the middle triangle formed by the lateral epicondyle, radial head, and olecranon, using an 18-gauge needle. The 2 arthroscopic portals were fashioned. First, the proximal anteromedial portal was made 2 cm proximal and 2 cm anterior to the medial epicondyle through a 3-mm skin incision using a No. 11 blade scalpel. Blunt subcutaneous dissection with a hemostat was performed, and a blunt trocar was introduced into the joint, followed by a 30° arthroscope. The proximal anterolateral portal was similarly created 2 cm proximal and 2 cm anterior to the lateral epicondyle under direct vision using a spinal needle. Skin incision, blunt dissection, and trocar insertion followed as for the medial side. On introduction of the arthroscope, a full intra-articular joint inspection was performed and intra-articular pathology including synovitis, osteophyte formation, and loose bodies was addressed at this point. The lateral epicondyle and common extensor origin were visualized using the medial portal. A 30° arthroscope allows excellent visualization of the lateral capsule and ECRB tendon, as well as the lateral epicondyle itself. The ECRB tendon was identified, and release was performed from the most distal level of pathologic involvement proximally to the insertion site on the lateral epicondyle. Pathologic tissue was resected. The lateral epicondyle was then similarly debrided at the ECRB origin. Finally, all instruments were removed, and the skin incisions were closed with sterile bandages.

Postoperative Rehabilitation. All patients were instructed on active range-of-motion exercises for the digits, wrist, shoulder, and elbow within the limits of the dressing applied postoperatively. Wrist and elbow active range-of-motion exercises were to be performed separately to avoid stress on the radial extensors and extensor digitorum communis. Patients attended a follow-up visit with their surgeon at 7 to 14 days, with a referral to physiotherapy at that appointment. Patients from both groups were not permitted to return to work for 6 weeks. This restriction allowed for wound healing and the initiation of physiotherapy. There may have been some patients who could have returned to work sooner. However, postoperative restrictions were standardized between groups because of the broad range of patient occupations and the risk of some duties having a negative impact on outcomes.

All patients were instructed to follow the same physiotherapy regimen. No alternative therapies were permitted in the year after surgery, including steroid or other injections, acupuncture, and extracorporeal shock wave therapy. Patients were informed of these restrictions before consenting for surgery. In an attempt to control the postoperative physiotherapy, the guidelines and protocol were included with the referral for treatment (Table 1).

Data Analysis

The sample size was calculated a priori as 40 patients per group based on 80% power, a 2-tailed significance level of .05, and an effect size of 0.7, which had been previously observed with the DASH questionnaire.[18] An additional 10% was included to allow for loss to follow-up, so 44 patients per group was the target. Patient enrollment was much slower than anticipated; therefore, recruitment was terminated early, and the study failed to meet the planned sample size. Recruitment tailed off dramatically in the last year of the study,

Table 1. Guidelines for Postoperative Rehabilitation

Postoperative Time Point	Guidelines
2 wk	Bulky dressing removed
	Active range-of-motion exercises reviewed with patient; elbow exercises performed initially with wrist in extension or neutral position and wrist exercises performed with elbow flexed to gradually stress the wrist extensors and EDC
	Scar massage
	Modalities to decrease inflammation
	Surgeons requested acupuncture not to be used in study patients
	Edema control
5-6 wk	Passive range of motion, starting with elbow flexed and progressing to extended
6-12 wk	Progressive strengthening exercises of wrist, forearm, elbow, and shoulder in pain-free range

EDC, extensor digitorum communis.

which is why recruitment was closed. The number of surgical consultations for this patient population diminished as primary care practices shifted to more nonoperative options; therefore, it was believed that continuing with recruitment would risk negating the relevance of the study, especially because it had already been open for 10 years.

Descriptive statistics were calculated by group for demographic information. Independent *t* tests were conducted for comparisons of continuous demographic data, as well as at each time point, to compare groups with respect to DASH, VAS pain, and PRTEE scores and grip strength in the elbow-flexed and elbow-extended positions. For categorical demographic data, χ-square tests were used. To compare within-group changes in all subjective outcome measures and strength over time, we performed a series of paired *t* tests using Bonferroni correction for multiple comparisons. This was done in lieu of repeated-measures analysis of variance to use all data collected and avoid list-wise omission of a participant's data if he or she was missing any follow-up visits. A minimal clinically important difference for the DASH score had been previously identified as 15 points and was used to compare the groups as well.[15]

Results

Between 2002 and 2014, 75 participants consented and were randomized: 37 to the open group and 38 to the arthroscopic group. Patient flow through the study is presented in the CONSORT (Consolidated Standards of Reporting Trials) diagram in Figure 1. One patient in the open group was randomized but was not included in the analysis because no data, other than consent, were collected. Demographic information for the 2 study groups is presented in Table 2. There were no significant differences between groups in age, sex, or preoperative subjective scores. No complications were identified in either group. The duration of surgery was longer in the arthroscopic group than in the open group: 34.0 minutes (standard error of the mean [SEM], 2.9 minutes) versus 22.5 minutes (SEM, 1.3 minutes). There were 2 participants who underwent additional procedures in the arthroscopic group: debridement of the synovium for mild synovitis in 1 and a radial capitellum joint adhesion release in 1. The added time (<5 minutes) for each of these procedures would not have influenced the significant difference found in surgery duration.

DASH scores are presented by group and time point in Table 3, with a lower score reflecting a more positive outcome. There were no significant differences in DASH scores between the groups at any time point. There was a significant improvement in both groups from preoperatively to 12 months postoperatively, with mean differences of −24.2 (SEM, 4.0) in the open group ($P < .001$) and −30.4 (SEM, 4.2) in the arthroscopic group ($P < .001$). In the open group, the DASH scores improved incrementally at each follow-up visit, with *P* values ranging from $P < .001$ to $P = .01$. In the arthroscopic group, the improvement was only statistically significant between preoperatively and 3 months postoperatively ($P < .001$).

The number of participants who reached the threshold for the minimal clinically important difference in DASH score by the 12-month time point did not differ between groups. In the open group, 62% of patients (18 of 29) improved compared with 66% (20 of 30) in the arthroscopic group.

No significant differences in VAS pain scores between groups were found at any time point (Table 3), with preoperative pain scores of 61.3 (SEM, 3.0) in the open group and 64.2 (SEM, 2.6) in the arthroscopic group improving to 30.5 (SEM, 4.9) and 26.9 (SEM, 4.2), respectively. The decrease in pain was significant from preoperatively to 12 months after surgery in both study groups based on VAS scores ($P < .001$ for both). On the basis of post hoc analyses, pain decreased significantly from preoperatively to 3 months ($P < .001$) and from 3 to 6 months ($P < .001$) in the open group. In the arthroscopic group, a significant change was seen only from preoperatively to 3 months postoperatively ($P < .001$).

No significant differences between groups were found in PRTEE scores at any time point (Table 3), with a lower score indicating a more positive outcome. Preoperatively, the mean scores were 56.3 (SEM, 3.1) in the open group and 61.1 (SEM, 2.8) in the arthroscopic group. By 12 months, the scores had improved to 24.6 (SEM, 4.4) and 23.9 (SEM, 4.2), respectively. The PRTEE scores improved incrementally between time points in the open group, whereas in the arthroscopic group, only the improvement from preoperatively to 3 months postoperatively was significant ($P < .001$).

With respect to grip strength, no differences were noted between groups at any time point (Table 3). There was an improvement in grip strength on the affected side in the open group from before surgery to 12 months after surgery ($P = .011$). Both groups showed an improvement from before surgery to 12 months after surgery when grip strength was measured with the elbow in full extension. On the basis of post hoc analyses, a significant improvement in the arthroscopic group was measured between preoperatively and 3 months postoperatively ($P = .001$), whereas in the open group, this was measured between 3 and 6 months postoperatively ($P = .004$).

Discussion

There was an improvement from preoperatively to 12 months postoperatively in pain and function with both arthroscopic and open release of the ECRB, as

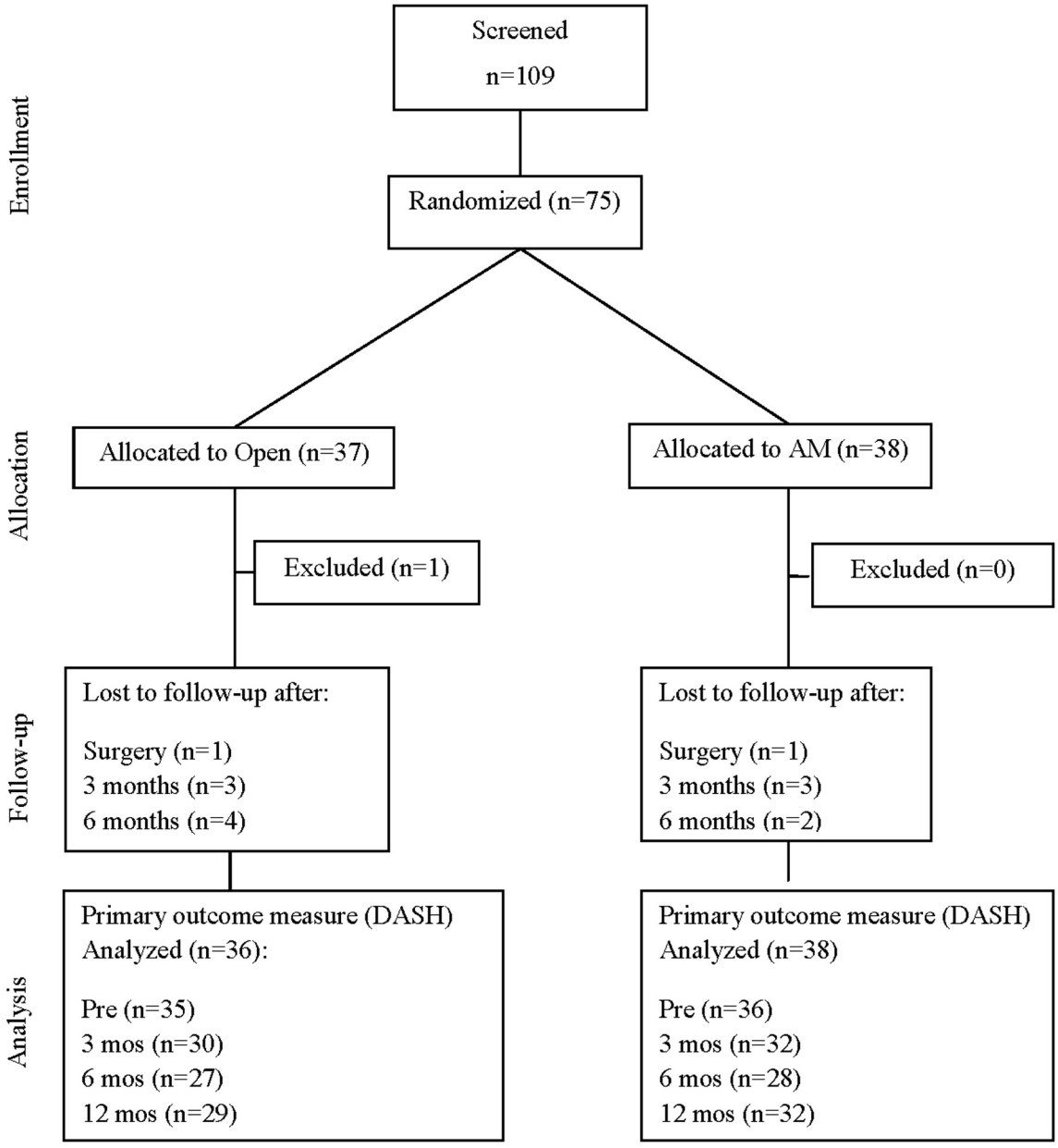

Fig 1. Patient flow through study. (AM, arthroscopic; DASH, Disabilities of the Arm, Shoulder and Hand score; Pre, preoperatively.)

measured by DASH scores, and no difference was found between these approaches at any time point. Similarly, improvement occurred with both approaches, with no differences between groups with respect to the VAS pain score, PRTEE score, and grip strength at any time point. The duration of the arthroscopic procedure was greater than that of the open procedure.

In a prospective case series, Baker et al.[17] examined the outcomes of 39 patients who underwent arthroscopic release. At an average follow-up of 2.8 years, 37 felt "better" or "much better" and grip strength returned to 97% of the opposite side. Return to work occurred at an average of 2.2 weeks after surgery. In another case series study,[19] 16 patients were followed up until 24 months after surgery. All patients improved, with return to work at 6 days on average.

Our study findings are consistent with a 2004 retrospective review of 54 open versus 33 arthroscopic release procedures, in which no difference between groups was found with respect to subjective outcome.[20] The proportion of patients reporting good or excellent outcomes was 69% for open release versus 72% for arthroscopic release. The authors reported a shorter rehabilitation period and a quicker return to work in the arthroscopic group, but this difference was not statistically significant. In contrast, a recent case-control series compared 80 open versus 225 arthroscopic release procedures at 3 to 6 years after surgery and

Table 2. Demographic Information by Group

Parameter	Open	Arthroscopic	*P* Value
Age, yr	46.9 (1.2)	45.6 (1.1)	.404
Sex (F/M), n	18/19	16/22	.569
Preoperative DASH score	46.5 (2.5)	52.6 (2.6)	.100
Preoperative VAS score	61.3 (3.0)	63.7 (2.6)	.552

NOTE. Data are presented as mean (standard error of the mean) unless otherwise indicated.

DASH, Disabilities of the Arm, Shoulder and Hand; F, female; M, male; VAS, visual analog scale.

observed benefits of the arthroscopic approach.[21] The mean score on the QuickDASH questionnaire (short version of the DASH questionnaire) was statistically significantly better in the arthroscopic group (11.6 [standard deviation, 15.6] vs 17.8 [standard deviation, 19.4]; $P = .004$), and the arthroscopic group reported a significantly higher number of excellent outcomes (78% vs 67%, $P = .04$). The authors indicated that because both approaches resulted in largely positive outcomes, the ability of subjective scores to detect a difference in techniques may be hindered by a ceiling effect. In our study, both groups had mean DASH scores at 12 months that were virtually identical (22.1 and 22.4 for the open group and arthroscopic group, respectively), with some latitude for further improvement; therefore, the impact of a ceiling effect in this case is unlikely.

A systematic review of Level I and II evidence, comparing arthroscopic, open, and percutaneous approaches, did not find clinically significant differences in terms of functional outcome (DASH score), pain intensity (VAS score), and patient satisfaction at 1-year follow-up in the 6 studies that the authors reviewed.[22] Variation in reporting methods, with some studies not reporting standard deviations, made statistical comparison of outcome measures unfeasible.

Other studies have reported on the rate and time to return to work. It was not possible to compare this element between groups in our study because 1 of the postoperative restrictions was that patients could not return to work until at least 6 weeks after surgery. This decision was made to standardize the time for adequate wound healing and the initiation of physiotherapy between groups. Alternatively, the study could have been designed to measure time to return to work as an outcome; however, the participants came from varied work and recreational backgrounds with a broad range of duties, which would have made drawing conclusions more difficult than in a more homogeneous population. An interesting finding was that the trajectory of recovery within the existing study design was not identical, with the majority of improvement in the arthroscopic group taking place by 3 months postoperatively and the improvement in the open group being more incremental to 12 months. In addition,

Table 3. Mean Subjective and Functional Outcomes by Group and Time Point With Within- and Between-Group Comparisons

Outcome	Preoperative	3 mo	*P* Value for Preoperative vs 3 mo*	6 mo	*P* Value for 3 mo vs 6 mo*	12 mo	*P* Value for 6 mo vs 12 mo*	*P* Value for Preoperative vs 12 mo*
DASH, %								
Open group	46.5 ± 2.5	35.0 ± 3.6	.001*	26.2 ± 3.9	<.001*	22.2 ± 3.8	.010*	<.001*
Arthroscopic group	52.6 ± 2.6	33.0 ± 3.2	<.001*	27.6 ± 3.7	.056	23.5 ± 4.1	.210	<.001*
P value	.10	.69		.80		.82		
VAS score, %								
Open group	61.3 ± 3.0	39.2 ± 4.0	<.001*	32.8 ± 4.9	<.001*	30.6 ± 4.9	.233	<.001*
Arthroscopic group	64.2 ± 2.6	37.4 ± 3.5	<.001*	33.6 ± 4.7	.157	26.9 ± 4.2	.017	<.001*
P value	.46	.73		.91		.56		
PRTEE, %								
Open group	56.3 ± 3.1	37.2 ± 4.4	<.001*	29.5 ± 4.9	.005*	24.6 ± 4.4	.006*	<.001*
Arthroscopic group	61.1 ± 2.8	34.5 ± 3.5	<.001	32.0 ± 4.9	.396	23.9 ± 4.2	.037	<.001
P value	.26	.64		.72		.91		
Grip strength with elbow bent, kg								
Open group	24.0 ± 2.8	27.7 ± 3.2	.039	29.1 ± 2.6	.046	28.4 ± 3.1	.644	.011*
Arthroscopic group	19.9 ± 2.5	25.9 ± 2.5	.044	27.5 ± 2.8	.203	29.2 ± 2.9	.140	.058
P value	.28	.65		.69		.84		
Grip strength with elbow extended, kg								
Open group	21.8 ± 2.6	25.3 ± 2.9	.160	29.2 ± 2.6	.004*	28.2 ± 2.7	.715	.002*
Arthroscopic group	14.9 ± 2.3	23.3 ± 2.4	<.001*	26.0 ± 3.0	.277	29.6 ± 3.1	.129	.001*
P value	.06	.60		.41		.75		

NOTE. Data are presented as mean ± standard error of the mean.

DASH, Disabilities of the Arm, Shoulder and Hand; PRTEE, Patient-Rated Tennis Elbow Evaluation; VAS, visual analog scale.

*Significance based on Bonferroni-corrected α ($\alpha = .05/4 = .013$).

strength improvements were seen most predominantly between preoperatively and 3 months postoperatively in the arthroscopic group as compared with between 3 and 6 months in the open group. It can be postulated that this early improvement would allow for an earlier return to work, depending on job demands; this may have been difficult to detect had participants returned to work earlier, disallowing the early improvements to be identified without impacts from varied demands of different occupations.

The duration of surgery was significantly shorter for the open procedure. This, coupled with the additional cost of arthroscopy supplies, as well as the time required to set up for an arthroscopic versus open approach, might make the open approach more favorable. With the recognition that this is only 1 group's experience, the study involved 3 contributing surgeons, which further substantiates this finding.

Lateral epicondylitis is a common elbow condition that can have a significant impact on a patient's quality of life. Operative management is pursued when patients have undergone at least 6 months of nonoperative management. This randomized clinical trial compared open versus arthroscopic surgery in the management of lateral epicondylitis and determined that, although there appeared to be some differences in the trajectory of recovery between groups, there were no statistical differences in operative modality when examining the DASH score, VAS score, PRTEE score, and grip strength in the 3-, 6-, and 12-month postoperative periods. A shorter operative time coupled with potentially less setup time may favor open release, but the decision of open versus arthroscopic release for the management of lateral epicondylitis can be made at the surgeon's discretion.

The strength of this study resides in the randomization and blinding of the assessor during all evaluations. In addition, the postoperative physiotherapy protocol was regimented to lessen the chance of additional physiotherapy additives that may influence the outcomes of surgery.

Limitations

The main limitation of this study lies in the lack of an untreated study group. Some studies have shown that patients can have resolution of symptoms with up to 18 months of nonoperative management. It is, however, difficult to explain to patients who have already undergone at least 6 months of nonoperative management that they should continue the same therapy that has not shown them the benefit of improvement. Another limitation is that the calculated number of subjects to adequately power this study was not reached. The target sample size was 44 patients per group with 10% (4 patients) included in each group to allow for loss to follow-up. In actuality, only 37 consented to undergo the open procedure and 38 consented to undergo the arthroscopic procedure. Of those, 29 and 32, respectively, completed the assessment at the final study time point. Another limitation of the study is treatment bias in the arthroscopic group. With visualization of the joint, any intra-articular pathology such as synovitis, osteophyte formation, and loose bodies would have been addressed. These pathologies would not have been identified or addressed as a potential source of pain in the open group. Finally, this study had an endpoint of 12 months because postoperative recovery is considered complete by this time and patients have returned to work. With similar outcomes between groups at 12 months, it is expected that later follow-up visits would not show any differences.

Conclusions

Comparing the open versus arthroscopic technique in the surgical management of lateral epicondylitis through a randomized clinical trial, we determined that there was no difference between the 2 operative modalities when examining the DASH score, VAS score, PRTEE score, grip strength, or complication rate at 12 months postoperatively. A shorter operative time coupled with potentially less setup time may favor open release.

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