SYSTEMATIC REVIEW

Clinical Outcomes of Open versus Arthroscopic Surgery for Lateral Epicondylitis, Evidence from a Systematic Review

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Abstract

Background: Lateral epicondylitis (LE) also known as tennis elbow is a common disease of middle-aged population. Surgery is a treatment of choice in patients not responded to the conservative management. Open and arthroscopic release are the two main choices for LE surgery; however, an overall consensus is not available. This study was aimed to compare the clinical outcomes after conventional open and arthroscopic procedures.

Methods: An electronic search of databases including, Medline, Web of Science, Embase, Cochrane Library, and Scopus was conducted to identify all eligible studies describing the post-operative clinical outcomes of patients with LE, up to October 2018. All studies considering the non-pediatric cases who received at least 6-month preoperative conservative treatment and were followed more than 6 months after surgery were included. Data on patient satisfaction, functional outcomes, pain, and complication rates, were extracted for each study. If appropriate, the meta-analysis was performed to combine the results for all outcomes that were reported in a minimum of 3 studies utilizing the same surgical technique.

Results: A total of 34 eligible articles including 15 open studies, 13 arthroscopic studies, and 6 studies in both techniques were enrolled. Studies were from different parts of the world with a whole sample size of 1508 cases. Various outcome measuring methods including Quick DASH and VAS, and different clinical outcomes were reported. The results indicated no significant difference between arthroscopic and open surgery methods in terms of VAS, DASH score, time for returning to work, overall outcomes, and patients' satisfaction ($P>0.05$). However, postoperative complications were significantly higher in the open group when compared with the arthroscopic procedure (57.3% vs 33.4% $P=0.001$).

Conclusion: The present study suggests that despite no superiority for each techniques regarding the pain relief, subjective function, and better rehabilitation, arthroscopic method have been associated with less complications.

Level of evidence: II

Keywords: Arthroscopy, Lateral epicondylitis, Open surgery, Systematic review, Tennis elbow

Introduction

Tennis elbow or Lateral epicondylitis (LE) is a common degenerative disorder with a prevalence rate of 1% to 3% in the general population and 7% in the handy workers, occurs most often between the ages of 40-60 years with equal gender distribution(1, 2). This condition is characterized by the tenderness

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of lateral epicondyle which is deteriorated with wrist dorsiflexion under resistance (3). The underlying physiopathology of LE is not fully known, but it has been proposed that it is caused due to repetitive activities and overuse of the extensor carpi radialis brevis that further activates the inflammatory processes Although it was termed to be a disease of sportsmen, nowadays is found to be an occupational disorder (4-6). Historically, LE was believed to be a self-limiting disease; however, persistent pain will be detected in the majority of patients even after 1 year of different conservative treatments (7-9) and subsequent local corticosteroid injections was also showed unfavorable results, mainly in those with a pain duration greater than 6 months (7-10). Several conservative treatment strategies, like manual work avoiding, immobilization, local or systemic anti-inflammatory drugs, physiotherapy, and radiofrequency have been established for pain alleviation (11-15). However, patients who have not respond to conservative treatments or those with a 6-month period of pain sensation are candidates for surgery intervention (9).

Different surgery techniques have been developed for LE are included denervation of the lateral epicondyle invented by Wilhelm and Gieseler and the incision of the extensor tendon described by Hohmann or the open Nirschl technique that was invented as a traditional open procedure in 1979 (16-19). Baumgard and Schwartz (1982) also proposed percutaneous release as a method without the need for general anesthesia (20). However, like other surgical procedures in different parts of the body such as the knee and the shoulder, there is a great tendency toward arthroscopic procedure, a technique that first was by baker et al. (21). Several studies reported that arthroscopic technique is more useful for intra-articular visualization with quick rehabilitation due to minimal incision and lower morbidity rate (21-29). However, there have been additional studies comparing the efficacy of arthroscopic technique with open procedure; which led to inconsistence results making the interpretation difficult for available reports. Despite more reports supporting the superiority of arthroscopic technique, the possibility of potential patient-related advantages of open approach cannot be ignored. Therefore, to investigate more subtle comparison between arthroscopic and open techniques in terms of patients' satisfaction, functional outcomes, pain relief, and complication rates, this systematic review and meta-analysis was conducted to derive a more comprehensive conclusion.

Materials and Methods

Search strategy

The present systematic review and meta-analysis is conducted according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (30). We comprehensively searched Medline, Web of Science, Embase, Cochrane Library, and Scopus databases for relevant publications up to October 2018. The search mesh terms and text words including "tennis elbows", "Lateral Epicondylitis", "surgery", "operative", "arthroscopy", "arthroscopic" were used individually or in various combinations with no language restriction. References list of the potential eligible articles were also searched in manual, for more related articles. Regarding the studies published by the same author or overlapping study cases, only the most recent or complete study was included.

Study selection

Publications were eligible to be included in this systematic review and meta-analysis they met the following criteria: (1) Case series/cohort studies assessing patients with documented lateral epicondylitis according to the history and physical examination, (2) Studies reporting the results of isolated arthroscopic, or open surgical treatment for lateral epicondylitis, (3) Studies comparing the results of arthroscopic vs open surgical treatment for lateral epicondylitis. Reviews, editorials, letters to the editor, case reports, animal studies, and all other studies that were conducted on pediatric cases and those assessing patients with presence of any further pathology or lesions that could affect the function of the elbow including cartilage and bone lesions, osteoarthritis and history of the surgery at the interface, were excluded. Potential eligible articles with a follow-up period less than 6 months, and studies in which surgery was performed before six months of conservative treatments were also excluded. Two independent reviewers (PP and HMM) screened articles titles and abstract for relevancy and full text retrieved according to the inclusion and exclusion criteria. Any disagreement was resolved through discussion with a third reviewer (AM).

Data extraction and quality control

Data were extracted from the included studies by two authors (PP and HM). Briefly, for each study, the following data were extracted; the first author´s name and year of publication, country, study design, number of subjects and elbows, gender, mean age , duration of symptoms prior to surgical intervention, mean period of conservative treatment, mean follow-up duration, and type of surgical technique. All data related to the clinical outcomes including the pain sensation and the function of articular interface after surgery in terms of Quick DASH (The Disabilities of the Arm, Shoulder and Hand), VAS (visual analogue scale), and complication rate were recorded (31). Depending on the type of studies (observational or trials) two quality assessment tools including Newcastle-Ottawa Scale (NOS) and Jadad scoring system were used to assess the quality of studies included (32). This evaluation was performed by two authors (PP and HMM) independently and any disagreements were resolved through team consensus.

Data synthesis and meta-analysis

Data related to the continues/categorical variables from all studies were pooled and reported as weighted mean ± standard deviation and frequency with percentage respectively. In the case of outcome metrics reported in 3 or more publications, a meta-analysis was also

performed to estimate a pooled risk ratio (RR) with 95% confidence interval (CI). Meta-analysis was conducted using Comprehensive Meta-analysis version 3 software. The heterogeneity was measured using the I2 index and Cochran Q test. An I2 > 50% with a significant Cochran Q test indicates considerable heterogeneity. In case of high heterogeneity, a random effect model was used; otherwise, we used a fixed model. Also, potential publication bias was assessed using Egger's linear regression test. *P <0.05* were considered significant.

Results

Literature Search

Using the aforementioned search strategy, 227 studies were identified. Following the title and abstract screening process, 43 studies were remained. After, a more detailed review on full-text 9 other studies were also extracted. Finally, a total of 34 studies were included in the analysis [Figure 1]. Among included studies, 15 studies examining open surgical technique, 13 studies assessed arthroscopic method and 6 compared both approaches (15, 21, 24, 25, 33-62).

Of the included studies, twenty three were retrospective cohorts, three case-control studies, six prospective cohort studies, and two non-randomized clinical trials (15, 21, 34-36, 45, 51, 54, 52, 60). Studies were from different parts of the world including USA, China, Korea, Norway, Germany, France, Japan, Belgium, UK, New Zeeland, and Canada. All the publications were written in English, except one in French (51). The main characteristics of the included studies such as the number of patients and elbows, mean age of the patients, mean period of symptom sensation, mean period of conservative treatment, follow up, and the measured outcomes are summarized in Table 1.

The 34 included studies comprised 1508 patients and 1622 elbows; among these, 1005 (62.0%) elbows underwent open and 617 (38.0%) elbows underwent arthroscopic approach. The mean age of the patients was 46.64 in the open group and 46.14 in the arthroscopic group. Around 44.4% of the patients were male in the open group and 47.3% were male in arthroscopic. Mean period of symptom sensation were shorter in open group than arthroscopic group (8.27 vs. 10.62

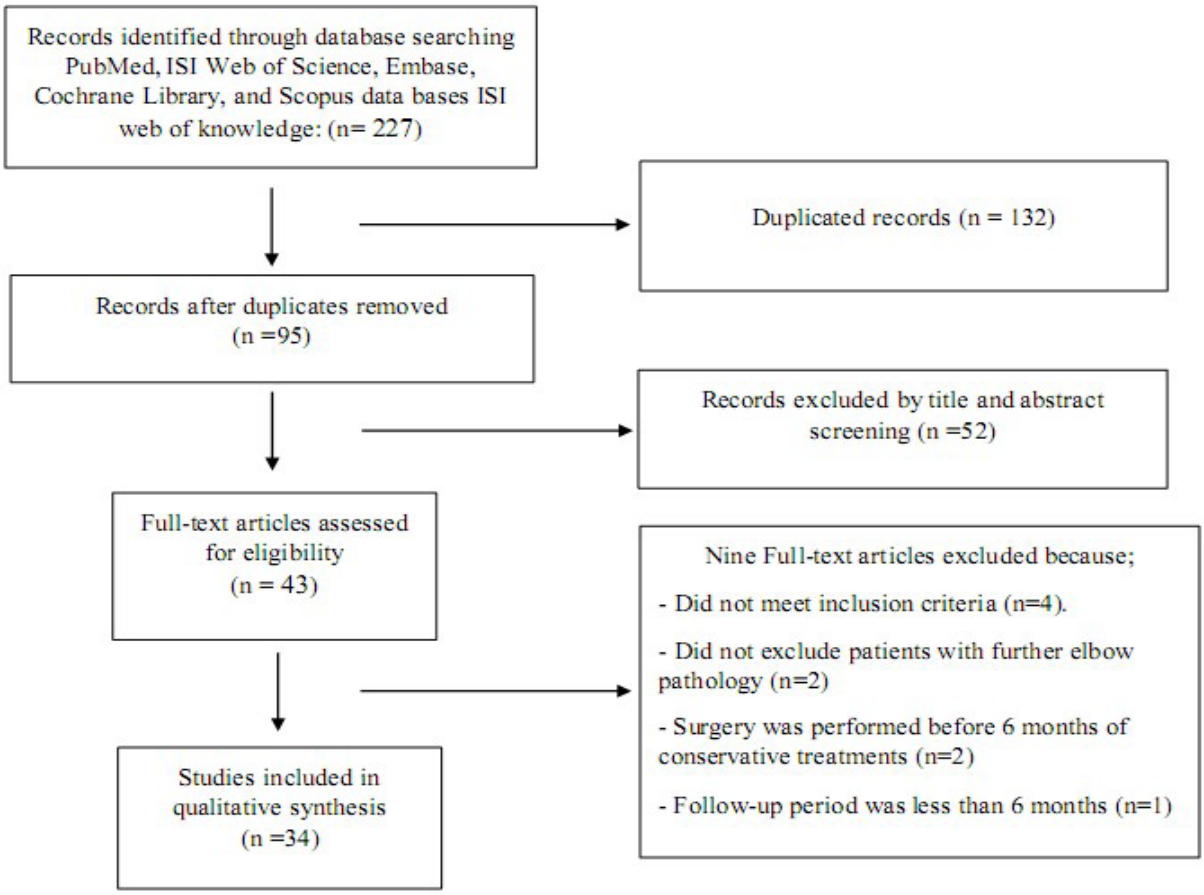

Figure 1. Flowchart of study selection process.

Table 1. Characteristics of studies included and outcomes measured

Study authors/year	Country	Study design	Study group or groups	Number and gender of patients (M/F)	Number of elbows and gender (M/F)	Mean age of the patients	Mean period of symptom sensation (months)	Mean period of conservative treatment (months)	Mean follow-up duration (months)	Outcome measured
Kwon BC et al, 2017	Korea	Retrospective cohort	Arthroscopic Open	55 (40/15)	31 (22/9) 28(20/8)	50.5	17.3	NR	30	VAS DASH PFG F-E arc Outcome
Solheim, et al, 2013	Norway	Case-control	Arthroscopic Open	295 (151/144)	225(111/114) 80 (42/38)	46	NR	NR	50	DASH Excellent & poor outcome
Yan H, 2009	China	Retrospective cohort	Arthroscopic Open	26 (NR)	31 (22/9) 12 (NR)	NR	NR	23	17.4	Excellent outcome
Szabo SJ et al, 2006	USA	Retrospective cohort	Arthroscopic Open	NR	41 (29/12) 38 (21/16)	45.7	NR	13.2	47.8	VAS Andrew-Carson score Recurrence Poor outcome
Rubenthaler F et al, 2005	Germany	Retrospective cohort	Arthroscopic Open	30 (18/12)	20 (11/9) 10 (7/3)	49.3	NR	10.6	92.8	VAS Roles & maudsley Morrey score
Peart et al, 2004	USA	Retrospective cohort	Arthroscopic Open	75	20 (NR) 46 (NR)	45	19	NR	31.5	Excellent & good & fair & poor outcome
Soeur et al, 2016	France	Retrospective cohort	Arthroscopic	35 (20/15)	NR	48	18	6	48	Quick-DASH Outcome Time for returning to work
Ruch et al, 2015	USA	Retrospective cohort	Open	27 (13/14)	NR	49.5	21.4	5	7.3	VAS DASH
Yoon et al, 2015	Korea	Retrospective cohort	Arthroscopic	45 (23/22)	NR	45.9	15.7	6	26.9	VAS patient satisfaction
Oki et al, 2014	Japan	Retrospective case-control study	Arthroscopic	23 (5/18)	23 (5/18)	49	32	6	24	VAS DASH Patients' satisfaction
Barth et al, 2013	Belgium	Cohort	Open	49	54 (23/31)	44	NR	NR	33	DASH VAS Outcome
Manon-Matos et al, 2013	USA	Retrospective case-control study	Open	56 (23/33)	NR	51.4	7.95	NR	NR	VAS Recurrence
Rhyou et al, 2013	Korea	Retrospective cohort	Arthroscopic	20 (4/16)	NR	47	14	NR	46	DASH VAS
Sauvage et al, 2013	France	Cohort	Arthroscopic	14 (6/8)	NR	39.8	NR	32.5	7.15	VAS DASH Outcome
Kim et al, 2011	Korea	nonrandomized clinical trial	Arthroscopic	19 (6/13)	19 (6/13)	46	6	6	29.5	VAS
Reddy et al, 2011	UK	Cohort	Open	27 (13/14)	NR	47	28	6	16	Patients satisfaction Time for returning to work
Solheim et al, 2011	Norway	Retrospective cohort	Open	77 (38/39)	80	46	NR	6	48	Quick DASH
Coleman et al, 2010	New Zealand	Retrospective cohort	Open	158 (72/65)	171	42	2.5	NR	117.6	Outcome
Dwyer et al, 2010	UK	Retrospective cohort	Open	21 (12/9)	NR	49.3	21	NR	24	Outcome Patients satisfaction

Table 1. Continued

Rayan et al, 2010	UK	Retrospective cohort	Open	40 (16/24)	40 (16/24)	43.7	12	NR	24	VAS Outcome
Lattermann et al, 2010	USA	Retrospective cohort	Arthroscopic	36 (24/12)	NR	42	19	NR	42	VAS Time for returning to work
Grewal et al, 2009	Canada	Cohort	Arthroscopic	36 (20/16)	NR	45.3	30	NR	42	VAS Outcome Time for returning to work
Dunn et al, 2008	USA	Retrospective cohort	Open	83 (45/38)	92	46	26.4	NR	151.2	VAS Outcome Patients satisfaction
Cho et al, 2009	Korea	Retrospective cohort	Open	41 (28/13)	42 (28/14)	47.5	NR	NR	13.4	VAS Outcome
Baker Jr et al/2000	USA	Cohort	Arthroscopic	40 (26/14)	42 (27/15)	42.7	14	14.4	34	VAS
Wada et al , 2009	Japan	Retrospective cohort	Arthroscopic	18 (9/9)	20	54	28	6	24	VAS DASH
Backer and Backer, 2008	USA	Retrospective cohort	Arthroscopic	40 (26/14)	42 (27/15)	42.7	14	14.4	130	Patients' satisfaction
Thomas and Broome, 2007	UK	Retrospective cohort	Open	18	24	NR	23	NR	NR	Patients' satisfaction
Jerosch et al, 2006	Germany	Retrospective cohort	Arthroscopic	20 (13/7)	NR	45.3	14	6	21.6	VAS Time for returning to work
Balk et al, 2005	USA	Retrospective cohort	Open	57	63	NR	NR	NR	50	Patients' satisfaction
Mullett et al, 2005	USA	Retrospective cohort	Arthroscopic	30 (16/14)	30 (16/14)	46	NR	9	24	Patients' satisfaction Time for returning to work
Tasto et al, 2005	USA	Nonrandomized clinical trial	Open	13 (6/7)	NR	48.3	4.4	6	24	VAS DASH
Thornton et al, 2005	USA	Cohort	Open	20 (9/11)	22	47.3	53	6	50.2	VAS DASH
Rayan and Coray, 2001	USA	Retrospective cohort	Open	22 (13/9)	23	43	NR	6	41.2	VAS Outcome Patients' satisfaction

Abbreviations: VAS, visual analog scale; DASH, Disabilities of the Arm, Shoulder and Hand; PFG, pain-free grip strength; F-E arc, F-E, flexion-extension, NR, not reported; M/F, Male/Female,

months). Patients in open group had a mean period of 19.66 months of conservative treatment and were followed for an average duration of 44.46 months while the conservative treatment and follow up duration were 17.75 and 42.08 months respectively in arthroscopic group [Table 2].

The values of postoperative outcomes measured either in arthroscopic or open groups as well as related complication are listed in Table 3.

Complications

The total amount of complications was 50 cases in both open and arthroscopic approaches. The complication rate was reported in 17 arthroscopic studies, 16 open studies [Table 4]. Complications noted were the flexion-extension limitation, revision surgery, superficial wound infection, hematoma, seroma, elbow instability, synovial fistulae, posterior interosseous nerve palsy, and need for further glucocorticoid injections. The rate of complications were significantly higher in open group than arthroscopic group (open: 57.3% vs. arthroscopic: 33.4%; *P: 0.001*) [Table 4].

VAS for pain score

Postoperative VAS pain scores were reported in Thirteen arthroscopic studies and eleven open studies (15, 25, 34, 35, 40-42, 45-47, 49-57, 59, 62). At final follow-up, the mean VAS was higher in the arthroscopic group but, the difference was not statistically significant (arthroscopic: 1.62±1.96 vs. open: 1.45±0.72; *P: 0.78*) [Table 4].

Table 2. Subject Demographics for Open & Arthroscopic

Parameter	Open	Arthroscopic
Number of elbows	1005	617
Mean age	46.64	46.14
Male (%)	44.4%	47.3%
Female (%)	55.56%	52.7%
Mean period of symptom sensation (months)	8.27	10.62
Mean period of conservative treatment (months)	19.66	17.75
Mean follow-up duration (months)	44.46	42.08

Table 3. The comparative values of postoperative outcomes

First author name	Item		Type of surgery		*P value*
			Open	Arthroscopic	
Kwon BC et al. (59)	Mean time for returning to work (month)		10.2±4.1	8.7±3.4	NR
	VAS score	Overall pain	1.1±1	1.1±1.8	0.08
		Pain during hard work	1.6±1.3	2.2±2	0.042
		Pain at rest	0.7±0.9	0.8±1.6	0.604
	Quick DASH score		9.4±7	12.6±18.3	0.408
	PFG strength (kg)		18±8	25±13	0.115
	F-E arc		149±3	149±4	0.803
	Outcome	Excellent	22 (84.6%)	22 (75.9%)	0.510
		Good	4 (15.4%)	5 (17.2%)	
		Poor	0	2 (6.9%)	
	Complications	1 (1.8%)	case of mild flexion-extension limitation in open group		(1.8%) 1
Soeur et al. (48)	Quick DASH score		NR	15.9	NR
	Good & excellent outcome		NR	71%	NR
	Mean time for returning to work (month)		NR	72	NR
	Complications	5 (12.5%)	local injections, 2 (5%) revision surgery, 1 subjective elbow instability		(2.5%) (5%) 2
Ruch et al. (33)	VAS		2.3	NR	NR
	DASH		44	NR	NR
	complications		Without any complication		
Yoon et al. (47)	Overall VAS		NR	0.9	NR
	Patients' satisfaction		NR	82%	NR
	Complications		Without any complication		
Oki et al. (49)	VAS	At rest	NR	8	NR
		At activity	NR	35	NR
	DASH score		NR	15	NR
	Patients' satisfaction		NR	96%	NR
	Complications		Without any complication		

Table 3. Continued

Barth et al. (34)	Quick DASH score			6	NR	NR
	VAS	Overall pain		1	NR	NR
		Pain at rest		9	NR	NR
	Mean time for returning to work (month)			5.7	NR	NR
	Outcome	Excellent		26 (54%)	NR	NR
		Good		15 (31%)	NR	NR
		Poor		8 (16%)	NR	NR
	Complications		2 (4%)	hematoma and 1 (2%) wound infection 1 (2%)		
Manon-Matos et al. (35)	VAS score			3	NR	NR
	Recurrence			2	NR	NR
Rhyou et al. (50)	VAS pain score			NR	0.3	NR
	VAS palpation pain score			NR	0.9	NR
	DASH score			NR	5.1	NR
	Complications			Without any complication		
Solheim, et al. (37)	Quick DASH score			17.8±19.4	±15.4 60.2	0.004
	Outcome	Excellent		67%	78%	0.04
		Poor		4%	7%	0.285
	Complications		19 (6.2%)	in Arthroscopic group & 3 (4%) in Open group 19 (6.2%) revision surgery		
Sauvage et al. (51)	DASH			NR	9.7	NR
	VAS	At rest		NR	0.43	NR
		At activity		NR	2.43	NR
	Mean time for returning to work (month)			NR	9.1	NR
	Outcome	Excellent		NR	11	NR
		Good		NR	3	NR
	Complications			Without any complication		
Kim et al. (52)	VAS at activity			NR	1.0	NR
	Mean time for returning to work (days)			NR	18.3 ± 24.2	NR
	Complications			Without any complication		
Reddy et al. (36)	Patients' satisfaction			90%	NR	NR
	Mean time for returning to work (month)			5	NR	NR
	Complications			Without any complication		
Solheim et al. (60)	Quick DASH score			18	NR	NR
	Complications		7 (9.2%)	revisions, 3 (4%) wound infections, and 1(1.2%) 3 (4%) hematoma		
Coleman et al. (38)	Outcome	Excellent		128 (85%)	NR	NR
		Good		13 (8%)	NR	NR
		Fair		6 (5%)	NR	NR
		Poor		2 (2%)	NR	NR
	Complications		2 (1.5%)	synovial fistulae 2 (1.5%)		

Table 3. Continued

Dwyer et al. (39)	Patients' satisfaction		95.2%	NR	NR
	Outcome	Excellent	19 (90.5%)	NR	NR
		Good	2 (9.5%)	NR	NR
	Complications		Without any complication		
Lattermann et al. (53)	VAS score		NR	1.9	NR
	Mean time for returning to work (month)		NR	7	NR
	Complications		Without any complication		
Rayan et al. (40)	Overall VAS		1.6	NR	NR
	Outcome	Excellent	25 (62.5%)	NR	NR
		Good	10 (25%)	NR	NR
		Fair	2 (5%)	NR	NR
		Poor	3 (7.5%)	NR	NR
	Complications	2 (5%)	patients required revision 2 (5%)		
Cho et al. (42)	VAS	At rest	0.3	NR	NR
		Daily activity	1.46	NR	NR
		Hard activity	2.21	NR	NR
	Outcome	Excellent	23	NR	NR
		Good	18	NR	NR
		Fair	1	NR	NR
		Poor	0	NR	NR
	Complications	1 (2.5%)	case of forearm paresthesias for 2 weeks after surgery		1 (2.5%)
Grewal et al. (54)	Overall VAS		NR	8	NR
	Mean time for returning to work with workers compensation (month)		NR	24.5 ± 32.6	0.2
	Mean time for returning to work without workers compensation (month)		NR	10.3 ± 16.6	
	Outcome	Good & excellent	NR	22	NR
		Fair	NR	9	NR
		poor	NR	5	NR
	Complications		Without any complication		
Dunn et al. (41)	Overall VAS for pain		2.1	NR	NR
	Patients' satisfaction		89%	NR	NR
	Outcome	Excellent	71 (77%)	NR	NR
		Good	6 (6.5%)	NR	NR
		Fair	9 (10%)	NR	NR
		poor	6 (6.5%)	NR	NR
	Complications		Without any complication		
Yan et al. (61)	Mean time for returning to work (month)		3	3.2	NR
	Excellent outcome		100%	93%	NR
	Complications		Without any complication		

Table 3. Continued

Wada et al. (55)	VAS	At rest	NR	0.3	NR
		At activity	NR	0.9	NR
	Quick DASH score		NR	10.6	NR
	Complications		Without any complication		
Baker and Baker (56)	Patients' satisfaction		NR	88%	NR
	Complications		Without any complication		
Thomas and Broome (43)	Patients' satisfaction		83%	NR	NR
	Complications		Without any complication		
Jerosch et al. (57)	VAS	At rest	NR	0.5	NR
		At daily activity	NR	1.0	NR
		At athletic activities	NR	1.2	NR
	Mean time for returning to work (month)		NR	3.2	NR
	Complications		Without any complication		
Szabo SJ et al. (25)	VAS score at worst pain		1.2	1	>0.05
	Andrew-carson		195.3	195.4	>0.05
	Recurrence		2 (4.9%)	5 (10.5%)	NR
	Poor outcome		5.3%	2.4%	NR
	Complications	9 (11.3%)	Arthroscopic cases & 2 (5/3%) open cases revision 1 (2.4%) surgery, and 2 (4.9%) Arthroscopic cases & 4(10/5%) open cases glucocorticoid injections		
Mullett et al. (58)	Patients' satisfaction		NR	93%	NR
	Mean time for returning to work (month)		NR	7	NR
	Complications		Without any complication		
Rubenthaler F et al. (62)	Mean time for returning to work (month)		3	3.3	>0.05
	VAS score	Pain	2.6	1.95	>0.05
		Function	2.5	1.85	>0.05
	Roles & Maudsley		2	3.3	>0.05
	Morrey score		87.5	93.2	>0.05
	Clinical tender spots on lateral epicondyle		3.2	2.4	>0.05
	Thompsen test		3.5	1.6	>0.05
	Chair test		2.4	1.8	>0.05
	Middle finger extetion test		3	1.4	>0.05
	Good & excellent outcome		60%	75%	>0.05
	Complications	(6.6%) 2	superficial subcutaneous infection (Arthroscopic) 1 (3.3%) (and 1 (3.3%) hematom (Arthroscopic		
Tasto et al. (14)	VAS score		0.7	NR	NR
	DASH		0.8	NR	NR
	Complications		Without any complication		
Thornton et al. (45)	VAS score		0.41	NR	NR
	DASH		6.6	NR	NR
	Time for returning to work (month)		4.1	NR	NR
Balk et al. (44)	Patients' satisfaction		97%	NR	NR

Table 3. Continued					
Peart et al. (24)	Mean time for returning to work (month)		2.5	1.7	>0.05
	Outcome with worker's compensation	Good & excellent	55%	72%	>0.05
		Fair	27%	18%	>0.05
		Poor	0%	18%	>0.05
	Outcome without worker's compensation	Good & excellent	83%	73%	>0.05
		Fair	17%	9%	>0.05
		Poor	0%	18%	>0.05
	Total outcome	Good & excellent	69%	72%	>0.05
		Fair	22%	21%	>0.05
		Poor	9%	7%	>0.05
Rayan and Coray (46)	Overall VAS		1.4	NR	NR
	Patients' satisfaction		96%	NR	NR
	Outcome	Excellent	11 (50%)	NR	NR
		Good	3 (13.5%)	NR	NR
		Poor	8 (36.5%)	NR	NR
	Complications	3 (13.5%)	mild to moderate pain, 1(4.5%) transient elbow stiff- ness, and 1 (4.5%) hematoma		(4.5%) 1
Baker Jr et al. (21)	VAS score at rest		NR	1.9	NR
	Complications		Without any complication		

NR: not reported; DASH: The Disabilities of the Arm, Shoulder and Hand; VAS: visual analogue scale; PFG: Pain Free Grip

Table 4. Comparison of Postoperative clinical outcomes following surgery

Parameter	Open			Arthroscopic			*P value*
	Value	Studies	n	Value	Studies	n	
Return to work (month)	8.9±4.6	7	272	6.3±3.6	11	199	0.195
Good and excellent outcome n (%)	82.7%	12	577	81.2%	8	407	0.418
Poor outcome	10.6%	13	628	8.4%	8	418	0.127
DASH	14.7±14.4	7	241	11.5±3.6	7	402	0.584
VAS	1.45±0.72	13	347	1.62±1.96	10	187	0.78
Complication n (%)	57.3%	16	737	33.4%	17	515	0.7
Patient satisfaction	91.7%	6	228	98.8%	4	138	0.3

DASH score

The postoperative DASH score was reported in 7 arthroscopic studies and 7 open studies (15, 33, 34, 37, 45, 48- 51, 55, 59, 60). At final follow-up, the mean DASH score was higher in the open group than in the arthroscopic approach; however, this was not statistically significant (arthroscopic: 11.5±3.6 vs. open: 14.7±14.4; *P: 0.584*) [Table 4].

Return to work

The duration to return to work following surgery was reported in 11 arthroscopic studies and 7 open studies (24, 34, 36, 45, 48, 51-54, 57-59, 61, 62). The mean time for returning to work was 6.3±3.6 months in arthroscopic group and 8.9±4.6 months in open group; however, no significant difference was found [Table 4].

Patient's satisfaction

Four arthroscopic and five open studies reported the proportion of patients who were satisfied with the results of the procedure (36, 39, 41, 43, 44, 47, 49, 56,

58). Totally, 98.8% of the patients in the arthroscopic group and 91.7% of the patients in the open group felt that their condition had been improved as a result of surgery. However, this difference was not statistically significant (*P = 0.30*) [Table 4].

Overall outcomes

The rate of good/excellent outcomes were reported in 8 arthroscopic studies and 12 open studies (24, 25, 34, 38-42, 46, 48, 51, 54, 59-62). Furthermore, the poor outcomes were reported in 8 arthroscopic articles and 13 open articles (24, 25, 34, 38-42, 46, 51, 54, 59-62).There was no significant difference between the groups regarding the rate of excellent/good outcomes (arthroscopic: 81.2% vs. open: 82.7%; *P: 0.418*). Although the poor outcome was higher in open group, the difference was not statistically significant (arthroscopic: 8.4% vs. open: 10.6%; *P: 0.127*) [Table 4].

Discussion

The primary purpose of this review was to determine if definitive evidence suggests that any of open or arthroscopic surgical treatment is superior to the other in patients with lateral epicondylitis. We tried to find a superiority in one of the methods regarding relieving pain, improving functionality, accelerating return to work and the safety according to the number of complications. Therefore, VAS score, DASH score, outcomes, patients' satisfaction, returning to work time, and complications were compared between the two approaches. The most striking finding of this study was that the rate of complications were significantly higher in open group than arthroscopic group (open: 57.3% vs. arthroscopic: 33.4%; *P: 0.001*). At final follow-up, there were no significant differences between groups regarding relieving pain, improving functionality, duration to return to work, overall good and excellent outcome, poor outcome and proportion who were satisfied. Average VAS and DASH scores at final follow-up showed no significant difference between the two study groups.

Seventeen arthroscopic studies and sixteen open studies (15, 21, 25, 33, 34, 36-43, 46-58, 59-62) reported the number of complication in their studies. Pooled results showed that the rate of complications was significantly higher in the open group than in the atheroscopic group (open: 57.3% vs. arthroscopic: 33.4%; *P: 0.001*).

The pooled results of the above-mentioned outcomes are summarized in table 4. As shown in this table only the rate of reported complications showed a notable differences which were higher in the open group. It is believed that arthroscopic method causes a minimal violation to the skin, underlying tissues, and extensor aponeurosis compared with the open method; therefore more complications such as postoperative bleeding and surgical traumas were observed in the open approach (25, 60).

It is in common that smaller incision leads to less pain and better function postoperatively. The percutaneous method has a smaller incision than open method; however, the open method provides a better visualization with the cost of greater incision and time-consuming recovery from surgery and maybe a bigger scar. Especially, in case of open surgery methods, the nirschl procedure needs much more care for rehabilitation. It is believed that the arthroscopic method combine the benefits of the two methods. While this method provides a good visualization of the surgery field, it is safe with small incision and scar. Although arthroscopic method is the most preferred surgery methods, the studies showed no superiority for each of the methods (24, 63-65). Our study showed no difference in the duration to return to work, VAS, and DASH scores between the two methods. In addition, both open and arthroscopic methods involved the removal of affected tissues with underlying bone decortication, and therefore there is no difference between the approaches regarding the function.

Some literatures suggested that there are several different open approaches; however, the top lied is Nirschl procedure or modified variations (3, 66-70). Each techniques had an underlying logic, and the majority of them showed good results; however, further randomized controlled trials are needed to assess the superiority of each technique. The development of different surgery approaches is due to different theories of the underlying pathology (71). Various ways are such as orbicular ligament releasing, wrist extensor muscles lengthening, common extensor origin releasing, and distal release of the extensor muscle (20, 71, 73). The reviewed literature suggested that the pathology lies in microscopic or macroscopic tears of the extensor muscle or tendons of the forearm mainly extensor carpi radialis brevis (ECRB) (11, 74, 75). Nirschl and Pettrone proposed ECRB tendon is the corner stone of the LE disease development (3). This pathology was further supported by electron microscopy findings such as hypervascularity, fibroblast accumulation, and abnormal contractile elements in the tendon (76).

In the arthroscopic approach, arthroscope can be used arthroscopically or endoscopically (77-79). Baker and Cummings (1998) proposed the technique being used arthroscopically for LE treatment (21). The technique was used to cut lateral capsule followed by debridement of observed abnormal tissue in ECRB and lateral epicondyle decortication. They proposed three types of involvement in LE macroscopic pathology during surgery. Type 1 was related to the inflammation and fraying of the ECRB in the absence of capsular tearing. Type 3 was presented with linear tears at the surface of the ECRB tendon. They found that the outcome of the patients was relatively good.

Our study had several limitations; the included studies were of different types; however, to the top of our knowledge no randomized controlled trial was conducted. Furthermore, the assessments were not complete in some studies, and some of them did not measure the pain and function scorings such as VAS or DASH. The sample sizes in most of the studies were low. Furthermore, only 6 studies compared the two methods; other studies reported one method outcomes which were further pooled and analyzed in this study. However, besides the above-mentioned limitations, this study can help to complete the superiority of each approaches to

the other.

According to our analysis there is no superiority in the mentioned surgical methods regarding the function improvement with less pain sensation. However, the number of complications such as mild flexion-extension limitation, hematoma, wound infection, revision requirement, forearm paresthesias for 2 weeks after surgery, and glucocorticoid injections requirements are significantly lower in the arthroscopic group than in the open approach. Our pooled analysis is a statistical assessment and further support is needed to report it as a clinical finding.

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