JPRAS Open 35 (2023) 89–101

Contents lists available at ScienceDirect

JPRAS Open

journal homepage: www.elsevier.com/locate/jpra

Review Article

"Anesthesia for Endoscopic Carpal Tunnel Syndrome Release: A Comprehensive Systematic Review and Meta-Analysis of Local Versus Regional Versus General Anesthesia"

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ARTICLE INFO

Article history:
Received 30 September 2022
Accepted 17 November 2022
Available online 23 November 2022

Keywords:
Carpal tunnel syndrome (CTS)
Endoscopic carpal tunnel release (ECTR)
Median neuropathy
General anesthesia
Regional anesthesia
Local anesthesia (LA)

ABSTRACT

Background: Worldwide, carpal tunnel syndrome (CTS) is the most common peripheral neuropathy due to compression. A minimally invasive endoscopic carpal tunnel release (ECTR) procedure is available to treat this condition. This study aims to identify and compare the different types of anesthesia in ECTR, particularly in terms of functional outcomes, patient satisfaction, and operative time.
Methods: PRISMA guideline was used to design and conduct this systematic review. MEDLINE, Cochrane, and EMBASE databases were searched systematically from inception to May 2022. For the

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https://doi.org/10.1016/j.jpra.2022.11.002

search, MeSH terms such as ECTR, general anesthesia, local anesthesia (LA), and regional anesthesia were used.

Results: As a result of reviewing the literature, 198 publications were reviewed. After implanting our criteria, 12 studies were included. We included 14589 patients who underwent ECTR. LA has a higher satisfaction rate and a shorter operative time than general anesthesia. LA had a mean operative time of 20.1 min, compared to 45 min and 51 min for regional anesthesia and general anesthesia. The number of patients with postoperative ECTR surgical complications was 2.7% (95%CI). After ECTR with LA, 95% of patients are back to their daily routine within six months.

Conclusion: All the reported methods were effective, with LA being the most commonly used. Furthermore, it showed a shorter operative time and a higher satisfaction rate than other types of anesthesia. Due to the heterogeneity of the data, we recommend future randomized controlled trials to highlight the differences in anesthesia types used in ETCR.

Level of evidence: III, risk/prognostic study

Introduction

Carpal tunnel syndrome (CTS) is the most common nerve compression of the upper extremity.[1] The estimated prevalence in the general population is 1.5% to 5%.[2] CTS is caused by compression of the median nerve in the osteofibrous canal located in the volar aspect of the wrist.[3] Currently, there is no known cause for CTS. Several risk factors have been identified, including diabetes mellitus, excessive wrist extension or flexion, vibration exposure, and arthritis.[3,4] CTS patients usually present with paresthesias and dysesthesias that occur intermittently during the night and become more frequent during the day. Later, if left untreated, loss of feeling followed by weakness and atrophy of the thenar muscles will develop.[3] Diagnosis of CTS is mainly clinically and via nerve conduction studies.[5] CTS can be treated conservatively or surgically; conservative treatments include corticosteroid injections, nonsteroidal anti-inflammatory drugs (NSAIDs), vitamins B6 and B12, and hand splints.[6]

In contrast, surgical release of CTS is one of the most common procedures in the upper extremity; in the United States, with up to 700,000 procedures are performed yearly using both open and endoscopic techniques. There are several types of surgical techniques for releasing carpal tunnel: open carpal tunnel release (OCTR), mini-OCTR, and endoscopic carpal tunnel release (ECTR).[6-8] In 1987, Okutsu introduced the endoscopic technique for releasing carpal tunnels.[9] ECTR is preferable over OCTR in terms of recovery time, postoperative pain, higher satisfaction rates, and cost savings by moving procedures to outpatient facilities and using local anesthesia (LA).[10,11]

Various anesthesia options are available in ECTR, including general anesthesia, LA, intravenous regional anesthesia, and peripheral nerve blocks. LA administration is quick and less time-consuming when compared to other options. However, since the LA may increase the synovial layers' bulk and the amount of free fluid at the operation site, which may affect the visibility, it became of limited interest.[12,13] There are no systematic reviews comparing outcomes of ECTR using LA versus other anesthesia options. In this study, we aim to compare LA with regional anesthesia and general anesthesia, particularly in terms of functional outcomes, patient satisfaction, operative time, perioperative pain, and complications.

Methods and Materials

Search Strategy

We designed this systematic review using Cochrane review methods and utilized preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines.[14,15] The following online databases were searched from inception to May 2022: MEDLINE, EMBASE, and Cochrane. They were searched using the following keywords to aid the search: (Carpal tunnel syndrome OR median nerve neuropathy OR CTS) AND (endoscopic carpal tunnel release OR endoscopic surgery OR closed carpal tunnel release) AND (general anesthesia OR local anesthesia OR WALANT OR wide-awake local anesthesia OR regional anesthesia). We strived to review available published literature that reported the results of identifying and comparing outcomes of ECTR using LA versus other options of anesthesia technique, particularly in terms of functional outcomes, patient satisfaction, operative time, perioperative pain, and complications. The International Prospective Register of Systematic Reviews was utilized in this review on February 17 and identified as (CRD42022352677).[15] This article adheres to the guidelines in the Declaration of Helsinki in 1975. Ethical approval was waived due to the nature of the study.

Screening and data extraction

Initial screening of articles by title and abstract was conducted by two independent groups consisting of four authors each, and the fifth author resolved any conflict of inclusion in both groups using Rayyan software.[16] Related articles underwent further analysis by full text to ensure relevance and applicability. Inclusion of articles was limited to (1) published from inception up to May 2022; (2) reported in English; (3) adult male and female patients above 18 years old; (4) patients with confirmed CTS; (5) inclusion of an ECTR treatment arm; and (6) articles were case reports, case series, or original articles.

Meanwhile, studies were excluded if they met one or more of the following criteria: (1) language other than English; (2) reported a systematic review, economic analysis, animal or cadaveric studies; (3) non-ECTR; and (4) reported no outcome of interest. The level of evidence was assigned to each of the included articles, following the criteria described in the American Society of Plastic Surgeons' rating levels of evidence and grading recommendations.[17]

Data extraction

Eligible articles underwent a full review with the primary interest of comparing regional vs. local vs. general anesthesia with regard to age and gender, major and minor surgery-related complications, major and minor anesthesia-related complications, symptom recurrences, reoperations, main presenting complaints, duration of presenting complaints, the total time needed to return to work or daily activities, satisfaction, postoperative pain, functional outcomes, and satisfaction. Pinch/grip strength, sensation (two-point discrimination and monofilament), and operating time are all factors to consider. In cases where we were unable to extract the full data from an article, we contacted the corresponding authors of the published articles. However, we did not receive a response from them.

Bias assessment

The methodological index for the nonrandomized studies (MINORS) assessment tool was used to assess the methodological quality and synthesis of nonrandomized control trials, prospective cohorts, and comparative studies. It is a validated 12-item tool designed to check the quality of nonrandomized surgical studies.[18] The randomized controlled trial studies were assessed for bias using the Cochrane risk-of-bias tool for randomized trials (RoB 2).[19] Randomization, allocation concealment, participant and employee blinding, observer blinding, incomplete data, and selective reporting were all evaluated, and each study category was given a "low risk," "high risk," or "some concern" rating. Two independent reviewers simultaneously evaluated the bias risk.

Statistical Analysis

The analysis was performed for the outcomes that were reported in three studies or more. To estimate the pooled prevalence of surgical complications, we used the inverse variance method with a restricted maximum-likelihood estimator for tau2 and a continuity correction of 0.5 in studies with zero cell frequencies. A random-effects model was employed in the instance of significant heterogeneity (I2 > 50%); otherwise, a fixed-effects model was used. Publication bias was assessed using funnel plots and Egger's test. Statistical significance was deemed at $p < 0.05$. The analysis was performed using RStudio (version 4.1.1).

Results

Literature findings

This systematic review found 198 published articles, including 121 articles from EMBASE, 65 from MEDLINE, and 12 from the Cochrane library. After removing duplicates, 135 articles remained for review. We initially retrieved 16 full-text publications. We included data from 12 studies in the present systematic review (Figure 1), and 11 studies were included in the meta-analysis.[10,20-30] These studies were published between 2001 and 2021. Six studies were published in European countries,[22,24-27,29] while the remaining studies were published in the United States. Two randomized clinical trials were included,[25,29] three studies were retrospective investigations,[23,27,28] and the rest were prospective cohort studies. For the following reasons, four articles were excluded: reported no outcome of interest (n = 3) and insufficient data were available (n = 1). Table 1 lists the features of each article included.

Study characteristics

A total of 87481 patients were reviewed in all the studies, with sample sizes ranging from 10 to 86687 patients. The majority of patients underwent open CTR procedures (n= 72892, 83.32%), whereas only 14589 patients (16.67%) underwent endoscopic surgeries. The study included 14589 patients who had undergone ECTR. The ages ranged from 26 to 92 years old. In all included studies, women were the majority (n = 9914/1450, 68.35%); in two articles, gender was not mentioned.[20,28] In seven articles, LA was administered,[12,20,22-24,27,28] two articles compared LA with regional anesthesia,[25,29] one article used only regional anesthesia (median and ulnar nerve block),[26] one article used LA with sedation versus WALANT only,[21] and one article compared general anesthesia or regional anesthesia versus LA.[29] Regarding the clinical and operative characteristics, the duration of presenting complaints of CTS was presented in two studies,[22,24] with a mean duration of 43.3 months. Chalidis et al.[22] found a range of 4-48 months in a study by Ly et al.[24]

For the hand laterality affected by CTS, only four articles mentioned the hand laterality of their patients.[10,20,26,27] As a whole, the right hand was more affected (n=138/235, 58.72%) than the left hand (n=97/235, 41.27%). Three articles described the endoscopic CTS release method using a single-port technique,[10,22,24] and two articles described the two-port chow method.[26,27] The rest of the articles didn't mention their endoscopic technique. A mean operative time of 20.1 min was achieved for LA, 45 min was achieved for regional anesthesia, and 51 min was achieved for general anesthesia.

Regarding patients' satisfaction, the rates of high satisfaction levels were generally higher in LA,[10,25] 88.0% in another study,[29] and 91.7% in a third study.[24] Other patients' and operative characteristics are listed in Table 2. The outcomes of surgeries and follow-ups are demonstrated in Table 2. Postoperative surgical complications were prevalent among 2.7% of patients (95%CI, 1.00 to 7.41, Figure 2). The pooled estimate showed a significant heterogeneity (I^2 = 77.53, ph <0.0001). More details about the types of these surgical complications are listed in Table 2. Anesthesia-related complications were reported in two studies. In a study by Delaunay et al.,[23] among 273 patients who underwent ECTR under LA, 41 (15.02%) experienced mild pain. In an RCT carried out by Nabhan et al.,[29] additional local anesthetic agents were required by 3/43 patients (6.98%) due to severe pain (Table 2). However, we could not conclude a pooled estimate of the prevalence of pain or other anesthesia-related complications due to the small number of studies concerned with such a type of complication.

Regarding other outcomes, the proportion of reoperation was mentioned in one study,[20] where two patients out of 138 (1.45%) underwent repeated surgery. Follow-up intervals were three months

Table 1
Characteristics of the included studies and surgeries.

Authors	Country	Study Design	Patients					Operative characteristics		Level of evidence
Groups (E/O)	Sample size	Age range	Gender (M/F)	Type of anesthesia	Surgical technique	Operative time (min)				
Allam et al. 2020[20]	USA	P	138/0	138	NA	NA	LA	ECTR	NA	II
Aultman et al. 2020[21]	USA	P	50/43	93	26-78	29/34	LA with sedation versus WALANT only	ECTR	NA	II
Chalidis et al. 2013[22]	Greece	P	85/0	85	29-79	23/62	LA	Single-port	31.2 mean	II
Delaunay et al. 2001[23]	USA	R	273/0	273	N/A	68/205	LA	ECTR (undefined)	N/A tourniquet was inflated for 12.6 ± 5.4 min	II
Ly et al. 2019[24]	Switzerland	P	24/0	24	39-92	4/16	LA (WALANT)	Single-port	14(7-25)	II
Nabhan et al. 2011[29]	Germany	RCT	43/0	43	41-69	18/26	LA versus RA	ECTR	L.A Group 28 ± 3.5 min IVRA Group 45 ± 3.9 min	II
Sørensen et al. 2012[25]	Denmark	RCT	38/0	38	31-76	5/14	LA versus RA	ECTR	7.3 (SD 3.3) min	I
Tulipan et al. 2018[10]	USA	P	156/0	156	n/a	26/36		single-port	n/a	II
Tuzuner et al. 2006[26]	Turkey	P	21/0	21	33-59	5/16	RA (Median and ulnar nerve block)	2-portal chow technique	NA	II
Tüzüner et al. 2005[27]	Turkey	R	10/0	10	35-58	2/8	LA	Two-portal Chow technique	N/A	II
Wellington et al. 2021[28]	USA	R	156/0	156	MT: (36.4-55.8) LT: (42.2-70.4) WALANT: (37.7-69.3)	NA	LA (WALANT)	ECTR	WALANT: 10 min MT: 11 min LT 11 min	II
Foster et al, 2017[30]	Turkey	R	2238/ 7273	2238	30-70	4409/9497	GA, LA, RA			

E: endoscopic surgeries; O: open surgeries; M: male; F: female; ECTR: endoscopic carpal tunnel; P: prospective; R: retrospective; RCT: randomized clinical trials; LA: Local anesthesia; GA: General anesthesia; RA: Regional anesthesia; WALANT: wide awake local anesthesia no torniquet.

Table 2
Surgical and functional outcomes after CTS surgeries.

Authors	Surgical complications	Anesthesia-related complications	Follow-up interval	Patient satisfaction	Postoperative pain
Allam et al. 2020[20]	Infection:6, neuropraxia:2, wound dehiscence:2, nerve laceration:0	NA	NA	NA	NA
Aultman et al. 2020[21]	NA	NA	NA	E(walant:7.26, mac:6.2)	Walant: H:6.2, Average:4, L:2.6. MAC: H:6,8, Average:5.8, L:3.3
Chalidis et al. 2013[22]	None	NA	12 m	NA	0.7 ± 1.4 (0–5)
Delaunay et al. 2001[23]	None	41 had mild pain	NA	NA	NA
Ly et al. 2019[24]	7 Incomplete visualization, 1 Conversion	NA	3 m	22 very good, 1 somewhat painful, 1 very unpleasant	NA
Nabhan et al. 2011[29]	1 patient complained of mild pain when the endoscope was inserted and required additional prilocaine.	3 patients from the group of LA required additional LA because of severe pain in the hand when the endoscope was inserted. One of these 3 patients also required sedation with 30 mg propofol for tourniquet pain.	NA	6 months after the operation, 88% of patients are satisfied	6 months after the operation, 11% of patients felt pain
Sørensen et al. 2012[25]	None	NA	NA	19 satisfied	Significantly less pain than others
Tulipan et al. 2018[10]	none	NA	3 m	53 happy, 2 not happy, 7 lost follow-up	4.81
Tuzuner et al. 2006[26]	None	NA	NA	NA	3 (14.2%) required further anesthesia
Tüzüner et al. 2005[27]	One patient developed neuropraxia in the third and fourth fingers postoperatively.	NA	12 m	NA	Early postoperative pain was observed in two wrists, appearing 10 days and two months after surgery, respectively.
Wellington et al. 2021[28]	Superficial infections:3 (2 LT, 1 WALANT), Aseptic Flexor Tenosynovitis: 2 (2 MT)	NA	NA	NA	NA
Foster et al, 2017[30]	NA	NA	NA	NA	NA

IVRA: intravenous regional anesthesia; LA: local anesthesia; WALANT: wide-awake, local anesthesia, no tourniquet; LT: local anesthesia with tourniquet; MT: monitored anesthesia care with tourniquet

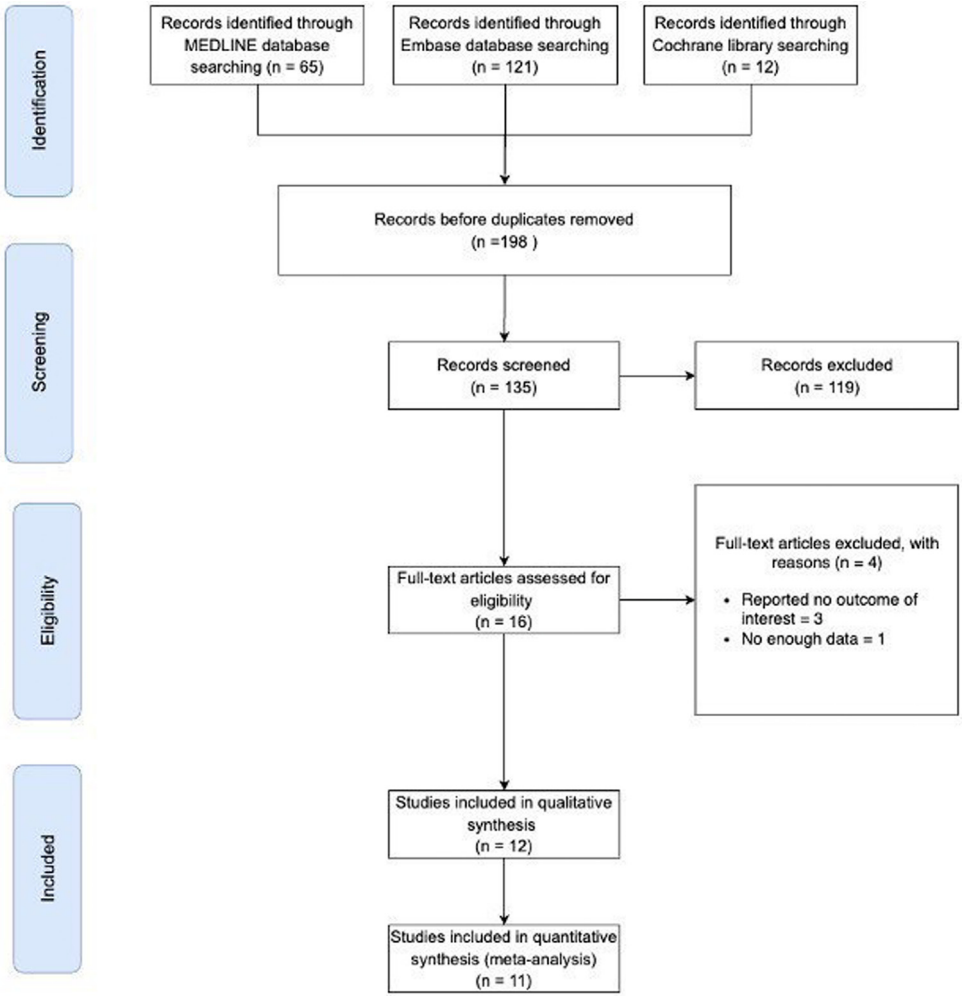

Figure 1. PRISMA flow chart for the systematic review.

in two studies[10,24] and one year in the other two studies.[22,27] According to one study,[29] 95% of patients returned to their daily activities within six months of undergoing a local anesthetic operation. S et al.[22] reported that the mean pinch/grip strength postoperatively was 6.64 ± 1.23 (Table 2). None of the patients developed symptoms of recurrence.

Publication Bias

Assessment of publication bias showed asymmetry in the funnel plot because small-sized articles were more likely to report prevalence rates lower than the mean pooled estimate. This was corroborated in the analysis of Egger's test, where the test value was -2.36 (95%CI, -4.22 to -0.49), with a p-value of 0.034 (Figure 3).

Quality Assessment and the Risk of Bias

The authors assessed randomized control trials, prospective and retrospective cohort included in the study. Two reviewers (AAB and AAL) evaluated the risk of bias separately and concurrently. Ten

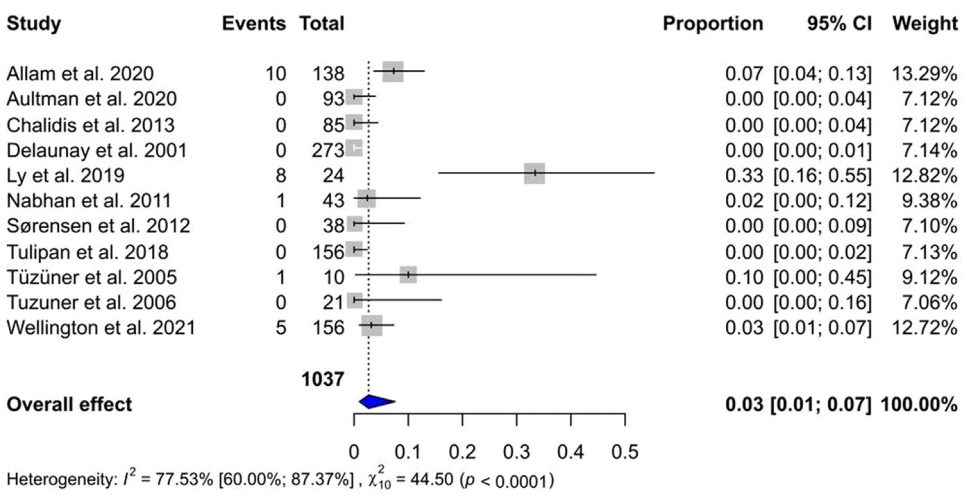

Figure 2. A forest plot shows the prevalence of post-surgery complications in included studies.

Table 3
MINORS instrument assessment for nonrandomized comparative studies (N=4)

Item	Tulipan 2018	Aultman 2020	Foster 2017	Wellington, 2021
A clearly stated aim	2	2	2	2
Inclusion of consecutive patients	2	0	0	0
Prospective collection of data	2	2	0	0
Endpoints appropriate to the aim of the study	2	2	0	0
Unbiased assessment of the study endpoint	2	2	0	2
Follow-up period appropriate to the aim of the study	2	1	0	0
Loss to follow-up less than 5%	2	1	0	0
Prospective calculation of the study size	2	2	0	2
An adequate control group	2	2	2	2
Contemporary groups	2	2	0	2
Baseline equivalence of groups	2	2	0	2
Adequate statistical analyses	2	2	0	1
Total score	24	20	4	13

nonrandomized studies were assessed by MINORS tool.[18] And two RCTs were assessed using Cochrane risk-of-bias tool for randomized trials (RoB 2).[19] The findings of both reviewers were the same, regardless of whether the material appeared biased. The nonrandomized studies considered had MINORS of at least 60%. There were four comparative studies, and they scored an average of 15.25 (range 4-24). The sex noncomparative studies had an average score of 7.5 (range 3-16). Tables 3 and 4 summarize the MINORS instrument assessment. The two RCTs show a high risk of bias in selection and performance with a low risk in other factors (Figures 4 and 5).

Discussion

The median nerve is the most common nerve compression in the upper extremities.[1] It is estimated that 1.5% to 5% of the general population is affected, with a higher incidence among females.[2] Carpal tunnel syndrome occurs when the median nerve is compressed in the osteofibrous canal located on the volar aspect of the wrist. In late 1989, Chow et al.[12] and Okutsu et al.[13] introduced the use of endoscopy in the release of median nerve compression, which demonstrated high superiority over the traditional technique of carpal tunnel release in terms of postoperative outcome, procedure time, satisfaction, and everyday functional recovery.[14] There are many options for anesthesia in ECTR,

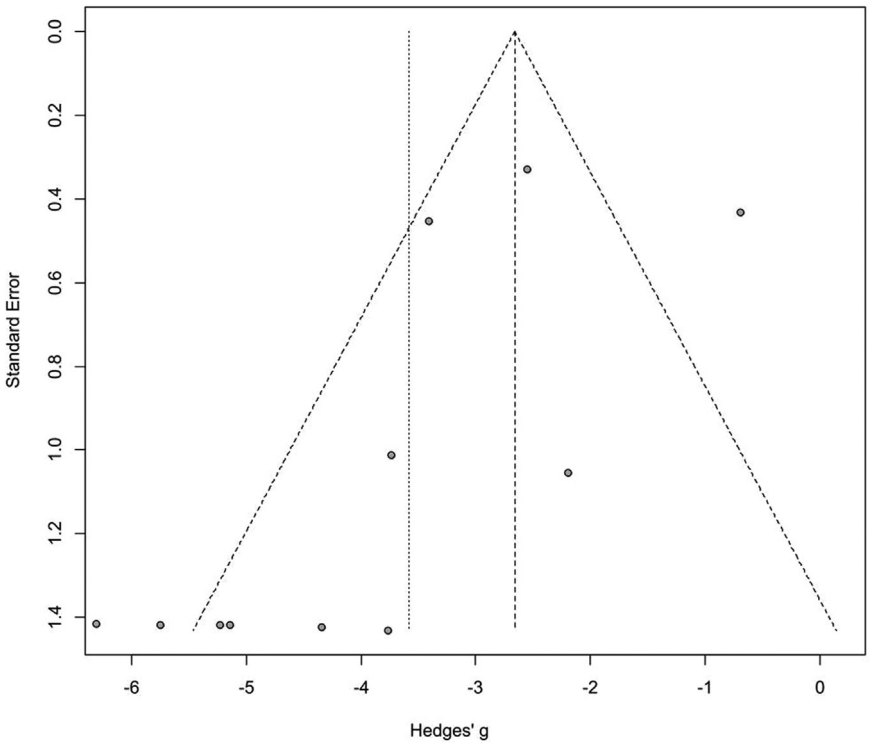

Figure 3. A funnel plot depicts the risk of publication bias.

Table 4
MINORS instrument assessment for nonrandomized noncomparative (studies (N=6).

Item	Delaunay, 2001	V. Ly, 2019	Tuzuner, 2006	Chalidis, 2013	Alla, 2020	TÜZÜNER, 2005
A clearly stated aim	1	2	1	2	2	1
Inclusion of consecutive patients	2	0	0	2	0	0
Prospective collection of data	0	2	0	2	0	0
Endpoints appropriate to the aim of the study	1	1	1	2	0	2
Unbiased assessment of the study endpoint	1	1	1	2	1	1
Follow-up period appropriate to the aim of the study	0	2	0	2	0	2
Loss to follow-up less than 5%	0	2	0	2	0	0
Prospective calculation of the study size	0	2	0	2	0	0
Total score	5	12	3	16	3	6

including general anesthesia, LA, intravenous regional anesthesia, and peripheral nerve blocks. Here, we compare LA with regional anesthesia and general anesthesia, particularly regarding patient satisfaction, operative time, pain, and complications.

We screened a total of 87481 patients, but only those who underwent ECTR (16.67%) were assessed and evaluated. There is no doubt that open CTR is the procedure of choice for treating median nerve compression, and the study's findings show that 83.32% of the reviewed studies used open CTR.[2] Despite this, we believe that ECTR will have a bright future in managing CTS.[11]

Based on our systematic review, the most common anesthesia technique for ECTR was LA,[12,20,22-24,27,28] which was mentioned in 7 articles, followed by LA with regional anesthesia administration.[25,29] Based on the results of our study, LA has a higher satisfaction rate and a shorter operative time than general anesthesia. A mean operative time of 20.1 min was achieved with LA,

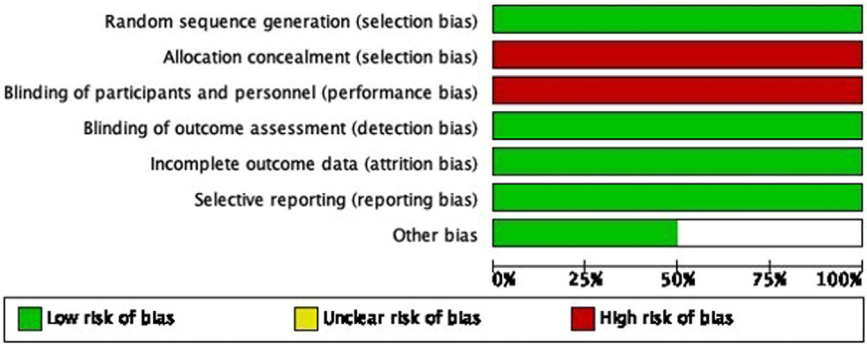

Figure 4. Risk of bias assessment graph.

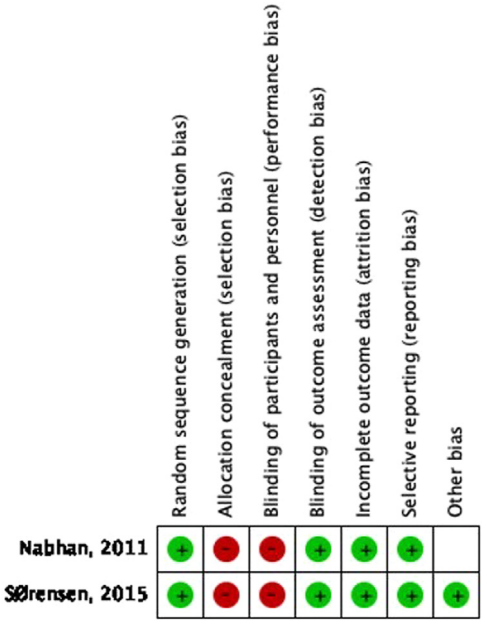

Figure 5. An overview of the bias risk assessment for the included RCT studies.

compared to 45 min and 51 min for regional anesthesia and general anesthesia, respectively. Generally, LA was associated with higher rates of patient satisfaction,[10,25] 88% in another study,[29] and 91.7% in a third study.[24] However, comparing the satisfaction rate to other types of anesthesia was impossible due to insufficient data. We found that only 2.7% developed postoperative complications, including infection, neuropraxia, and mild to severe pain. In a study by Nabhan et al.,[29] three patients out of 273 required sedation due to severe pain, which was explained by the long operative time of 28-45 min. A study by Allam et al.[20] reported that ECTR under LA had the highest rate of surgical complications. Six patients developed surgical site infections, two patients had neuropraxia, and two patients had wound dehiscence. The article did not provide enough information or explanation for the high rate of complications. Delaunay et al.[23] however, reported that 15% of patients experienced mild pain and that none required additional anesthetic injections, and postoperative evaluations revealed no surgical or anesthetic complications. Based on the high satisfaction rate reported in the included studies, we believe that ECTR under LA is highly safe with a lower risk of complications. The surgical

technique was reported in five studies; three used single-port endoscopy, and only seven operations had incomplete visualization, which led to further delays. Two studies used double-portal endoscopy. Even though the author didn't report any visualization problems during the procedure, they considered the limited view as one of the limitations of ECTR. Nonetheless, both techniques showed to be safe and preferable for postoperative pinch/grip and recovery.

Limitations and future recommendations

To our knowledge, this is the first systematic review and meta-analysis that compares different anesthetic techniques in ECTR. This study has several strengths, including the review of the current literature without a timeframe, the strict inclusion and exclusion criteria, and the reporting format according to PRISMA guidelines. According to MINORs' assessment tool, all included studies scored a mean of 22.75 for possible bias. There are, however, several limitations to our study. Since the number of included articles is low, we were not able to obtain significant findings. In addition, some essential information was missing from the literature. Only five articles reported operation times, four reported patients' follow-ups, and only two reported the duration of presenting complaints or functional outcomes. Additionally, some confounding factors, such as operation time, presence of comorbidity, and surgeon experience, were not controlled in some of the included studies, which might have generated bias. The risk of bias was comprehensively assessed, but we recommend that future studies control all these variables. Moreover, the heterogeneity and lack of sufficient data made it impossible to conclude the best type of anesthesia for ECTR. Therefore, we recommend randomized controlled trials to compare LA, regional anesthesia, and general anesthesia to highlight the differences in functional outcomes, patient satisfaction, operative time, complications, and overall costs.

Conclusion

The main objective of our review and meta-analysis was to identify and compare the most suitable types of anesthesia for ECTR. Each of the reported methods was effective, with the most commonly used method being LA, which was reported in 7 of the 12 articles. Additionally, it showed a shorter operative time and a higher satisfaction rate than regional and general anesthesia. Hand surgeons can use the results of our study to choose an appropriate type of anesthesia for ECTR based on the results of our study. For future studies, we recommend randomized controlled trials to allow precise comparison of the advantages and disadvantages of each type of anesthesia.

Statements and Declarations

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Competing Interests

The authors have no relevant financial or nonfinancial interests to disclose.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was waived due to the nature of the study.

Conflict of interest

The authors do not have any conflict of interest

Acknowledgment

This work was supported by the College of Medicine Research Center, Deanship of Scientific Research, King Saud University Medical City, King Saud University, Riyadh, Saudi Arabia.

References

1. Thoma, A., Veltri, K., Haines, T., & Duku, E. (2004). A meta-analysis of randomized controlled trials comparing endoscopic and open carpal tunnel decompression. *Plastic and reconstructive surgery*, 114(5), 1137–1146. doi:10.1097/01.prs.0000135850.37523.d0.
2. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosén I. Prevalence of carpal tunnel syndrome in a general population. *JAMA*. 1999;282(2):153–158. doi:10.1001/jama.282.2.153.
3. Padua L, Coraci D, Erra C, Pazzaglia C, Paolasso I, Loreti C, Caliandro P, Hobson-Webb LD. Carpal tunnel syndrome: clinical features, diagnosis, and management. *The Lancet. Neurology*. 2016;15(12):1273–1284. doi:10.1016/S1474-4422(16)30231-9.
4. Genova A, Dix O, Saefan A, Thakur M, Hassan A. Carpal Tunnel Syndrome: A Review of Literature. *Cureus*. 2020;12(3):e7333. doi:10.7759/cureus.7333.
5. Ibrahim I, Khan WS, Goddard N, Smitham P. Carpal tunnel syndrome: a review of the recent literature. *The open orthopaedics journal*. 2012;6:69–76. doi:10.2174/1874325001206010069.
6. Zamborsky R, Kokavec M, Simko L, Bohac M. Carpal Tunnel Syndrome: Symptoms, Causes and Treatment Options. Literature Reviev.. *Ortopedia, traumatologia, rehabilitacja*. 2017;19(1):1–8. doi:10.5604/15093492.1232629.
7. Via GG, Esterle AR, Awan HM, Jain SA, Goyal KS. Comparison of Local-Only Anesthesia Versus Sedation in Patients Undergoing Staged Bilateral Carpal Tunnel Release: A Randomized Trial. *Hand (New York, N.Y.)*. 2020;15(6):785–792. doi:10.1177/1558944719836237.
8. Olaiya OR, Alagabi AM, Mbuagbaw L, McRae MH. Carpal Tunnel Release without a Tourniquet: A Systematic Review and Meta-Analysis. *Plastic and reconstructive surgery*. 2020;145(3):737–744. doi:10.1097/PRS.0000000000006549.
9. Okutsu I, Ninomiya S, Takatori Y, Ugawa Y. Endoscopic management of carpal tunnel syndrome. *Arthroscopy: the journal of arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association*. 1989;5(1):11–18. doi:10.1016/0749-8063(89)90084-4.
10. Tulipan JE, Kim N, Ilyas AM, Matzon JL. Endoscopic Carpal Tunnel Release with and without Sedation. *Plastic and reconstructive surgery*. 2018;141(3):685–690. doi:10.1097/PRS.0000000000004113.
11. Li Y, Luo W, Wu G, Cui S, Zhang Z, Gu X. Open versus endoscopic carpal tunnel release: a systematic review and meta-analysis of randomized controlled trials. *BMC musculoskeletal disorders*. 2020;21(1):272. doi:10.1186/s12891-020-03306-1.
12. Nabhan A, Ishak B, Al-Khayat J, Steudel WI. Endoscopic Carpal Tunnel Release using a modified application technique of local anesthesia: safety and effectiveness. *Journal of brachial plexus and peripheral nerve injury*. 2008;3:11. doi:10.1186/1749-7221-3-11.
13. Wood SH, Logan AM. A local anaesthetic technique for endoscopic carpal tunnel release. *Journal of hand surgery (Edinburgh, Scotland)*. 1999;24(3):298–299. doi:10.1054/jhsb.1998.0213.
14. Moher D, Liberati A, Tetzlaff J, Altman DGPRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*. 2009;6(7):e1000097. doi:10.1371/journal.pmed.1000097.
15. Cumpston M, Li T, Page MJ, Chandler J, Welch VA, Higgins JP, Thomas J. Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. *The Cochrane database of systematic reviews*. 2019;10:ED000142. doi:10.1002/14651858.ED000142.
16. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. *Systematic reviews*. 2016;5(1):210. doi:10.1186/s13643-016-0384-4.
17. Sullivan D, Chung KC, Eaves 3rd FF, Rohrich RJ. The Level of Evidence Pyramid: Indicating Levels of Evidence in Plastic and Reconstructive Surgery Articles. *Plastic and reconstructive surgery*. 2021;148(5S):68S–71S. doi:10.1097/01.prs.0000794868.07051.b4.
18. Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (minors): development and validation of a new instrument. *ANZ journal of surgery*. 2003;73(9):712–716. doi:10.1046/j.1445-2197.2003.02748.x.
19. Sterne J, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng HY, Corbett MS, Eldridge SM, Emberson JR, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Higgins J. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ (Clinical research ed.)*. 2019;366:l4898. doi:10.1136/bmj.l4898.
20. Allam O, Park KE, Carney M, Kim S, Craig M, Thomson JG, Prsic A. Safety of Endoscopic Carpal Tunnel Release Performed Under Local Anesthesia. *Plastic and Reconstructive Surgery Global Open*. 2020;8(9 Suppl).
21. Aultman H, Roth CA, Curran J, Angeles J, Mass D, Wolf JM, Mica MC. Prospective Evaluation of Surgical and Anesthetic Technique of Carpal Tunnel Release in an Orthopedic Practice. *The Journal of hand surgery*. 2021;46(1) 69.e1–69.e7. doi:10.1016/j.jhsa.2020.07.023.
22. Chalidis BE, Dimitriou CG. One portal simultaneous bilateral endoscopic carpal tunnel release under local anaesthesia. Do the results justify the effort? *International orthopaedics*. 2013;37(8):1501–1505. doi:10.1007/s00264-013-1951-0.
23. Delaunay L, Chelly JE. Blocks at the wrist provide effective anesthesia for carpal tunnel release. *Canadian journal of anaesthesia = Journal canadien d'anesthesie*. 2001;48(7):656–660. doi:10.1007/BF03016199.
24. Ly TV, Urban V, Meuli-Simmen C, Pasternak I. Endoscopic Carpal Tunnel Release Using Wide-Awake Anesthesia. *Journal of hand surgery global online*. 2019;2(1):13–15. doi:10.1016/j.jhsg.2019.10.005.
25. Sørensen AM, Dalsgaard J, Hansen TB. Local anaesthesia versus intravenous regional anaesthesia in endoscopic carpal tunnel release: a randomized controlled trial. *The Journal of hand surgery, European volume*. 2013;38(5):481–484. doi:10.1177/1753193412453664.
26. Tuzuner T. Median and ulnar nerve block for endoscopic carpal tunnel release. *Advances in therapy*. 2006;23(6):902–904. doi:10.1007/BF02850212.

27. Tuzuner T, Ozturan K, Subasi M, Karaca E. The use of local anesthesia in endoscopic release of the carpal tunnel. *Acta orthopaedica et traumatologica turcica*. 2005;39(1):35–38.
28. Wellington I, Cusano A, Ferreira JV, Parrino A. WALANT Technique versus Sedation for Endoscopic Carpal Tunnel Release. *Hand (New York, N.Y.)*. 2021 15589447211003180. Advance online publication. doi:10.1177/15589447211003180.
29. Nabhan A, Steudel WI, Dedeman L, Al-Khayat J, Ishak B. Subcutaneous local anesthesia versus intravenous regional anesthesia for endoscopic carpal tunnel release: a randomized controlled trial. *Journal of neurosurgery*. 2011;114(1):240–244. doi:10.3171/2008.2.17395.
30. Foster BD, Sivasundaram L, Heckmann N, Cohen JR, Pannell WC, Wang JC, Ghiassi A. Surgical Approach and Anesthetic Modality for Carpal Tunnel Release: A Nationwide Database Study With Health Care Cost Implications. *Hand (New York, N.Y.)*. 2017;12(2):162–167. doi:10.1177/1558944716643276.