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REVIEW ARTICLE

A systematic review and meta-analysis comparing open versus endoscopic in situ decompression for the treatment of cubital tunnel syndrome

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Abstract

To examine whether endoscopic in situ decompression (EISD) or open in situ decompression (OISD) would have superior outcomes with lower morbidity in patients with idiopathic cubital tunnel syndrome, we reviewed all studies compared both surgical techniques with regard to postoperative outcomes and complication profile in a systematic review design with meta-analysis. Two independent reviewers conducted a PRISMA-compliant search of PubMed, EMBASE, and the Cochrane Library databases for relevant studies about clinical comparisons of OISD and EISD in cubital tunnel syndrome. We performed all meta-analyses with the Review Manager 5.3 software. For dichotomous variables, the risk ratio (RR) and 95% confidence intervals (CIs) were calculated. For continuous variables, the mean difference (MD) and 95% CIs were calculated. The level of significance was set as $p < 0.05$. Finally, 8 articles with 582 patients finally were included in this meta-analysis. Pooled analysis showed that the difference in Bishop score, visual analogue scale score reduction, postoperative satisfaction, postoperative hematoma rate and secondary surgical procedures were not statistically significant between the EISD group and the OISD group ($p > 0.05$). However, pooled results showed that patients who underwent EISD had a greater improvement in the scar tenderness/elbow pain than did those who underwent OISD with statistical significance ($p < 0.0001$). This meta-analysis demonstrated that EISD and OISD for surgical treating cubital tunnel syndrome had equivalent efficacy regarding postoperative clinical recovery, whereas the incidences of adverse events of EISD were also same as those with the OISD technique.

Keywords Cubital tunnel syndrome · Open in situ decompression · Endoscopic in situ decompression · Systematic review · Meta-analysis

Abbreviations

EISD	Endoscopic in situ decompression
OISD	Open in situ decompression
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
RR	Risk ratio
MD	Mean difference
CIs	Confidence intervals
RCTs	Randomized controlled trials

Introduction

Ulnar nerve entrapment at elbow represents the second most common entrapment syndrome in upper extremity after carpal tunnel syndrome with an annual incidence of 20.9 per 100,000 [12]. The symptoms of cubital tunnel syndrome in patients are often related to numbness and tingling sensations in the ring and little finger as well as pain in the elbow and sensory changes after bending the elbow for a long time. When it becomes more severe, intrinsic muscle atrophy of the hand, loss of muscle tone and claw hand deformity will appear [1, 18]. If conservative therapy with rest, physical therapy, and splinting in patients with mild symptoms fails,

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or in patients with more severe symptoms, surgical nerve decompression is indicated [4]. However, no gold standard exists. Several studies showed comparable outcomes between endoscopic in situ decompression (EISD) with a higher complication rate with open in situ decompression (OISD) [3, 15]. However, the evidence is still insufficient and the choice is largely left to the surgeon's discretion.

In recent years, a minimally invasive technique has been introduced. In 1995, Tsai et al. [20] first reported on endoscopic decompression of the ulnar nerve, which coincided with the updating of endoscopic instruments. The advantages of this method are rapid recovery, less discomfort, less operative trauma, fewer complications and less postoperative scarring for the patient [10]. To examine whether EISD or OISD would have superior outcomes with lower morbidity in patients with idiopathic cubital tunnel syndrome, we reviewed all studies compared both surgical techniques with regard to postoperative outcomes and complication profile in a systematic review design with meta-analysis.

Materials and methods

Search strategy

To make an exhaustive search of all relevant literatures, two independent reviewers conducted a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)-compliant search [11] of PubMed, EMBASE, and the Cochrane Library databases for relevant studies about clinical comparisons of OISD and EISD in cubital tunnel syndrome. The following search terms were used: "ulnar nerve", "delayed ulnar neuritis", "cubital tunnel syndrome", "open decompression" and "endoscopic decompression". The retrieved results were last updated on February 4, 2019. References cited in the relevant literatures were also reviewed.

Eligibility criteria

We included studies that met the following conditions:

1. The study is a randomized controlled trials (RCTs) or retrospective controlled studies.
2. The target individuals had primary cubital tunnel syndrome (or ulnar neuropathy at the elbow) clinically and electrophysiologically, not caused by injury or surgery.
3. The target individuals treated by either OISD or EISD.
4. Outcomes at least including postoperative scores or other indices of clinical improvement.
5. Trials and studies in English.

Articles were excluded if they had any of the following characteristics:

1. Insufficient clinical outcome data in studies.
2. Reviews, letters or conference articles.

Two reviewers independently selected the potentially qualified RCTs and retrospective controlled studies according to the inclusion and exclusion criteria. Any disagreement was resolved by discussion and a conformity was reached.

Data extraction

Two independent reviewers extracted the data from eligible studies. Any discrepancy was either resolved by discussion or by involving a third reviewer when necessary until a consensus for all items was achieved. The outcome parameters pooled in this analysis included clinical and surgical parameters (Bishop score, postoperative satisfaction, visual analogue scale score reduction, scar tenderness/elbow pain and rate of complications (postoperative hematoma rate and rate of secondary surgical procedures).

Risk of bias assessment

Two authors independently used the 12 criteria recommended by the Cochrane Back Review Group to assess the risk of bias of the included RCTs [8]. If at least six of the criteria went through without serious flaws, studies were defined as meeting "low risk of bias". If not, we defined the studies as having "high risk of bias".

Quality of evidence assessment

Moreover, the GRADE (grades of recommendation, assessment, development, and evaluation) approach was used to rate the strength of evidence for all pooled outcomes. According to the assessment of study design, risk of bias, consistency, directness and precision, the quality of outcomes was categorized as very low, low, moderate, or high. The Newcastle–Ottawa Scale was adopted to assess observational studies [17].

Data analysis

We performed all meta-analyses with the Review Manager 5.3 software (Cochrane Collaboration, Oxford, UK). For dichotomous variables, the risk ratio (RR) and 95% confidence intervals (CIs) were calculated. For continuous variables, the mean difference (MD) and 95% CIs were calculated. The level of significance was set as $p < 0.05$. Standard errors, CIs, p values for difference in means, and interquartile ranges were transformed into standard deviation (SD),

where necessary, according to the Cochrane Handbook for Systematic Reviews of Interventions. Statistical heterogeneity was evaluated using the Chi-square test and Higgin's I^2 test. A p value of Chi-square test < 0.10 or $I^2 > 50\%$ indicated statistical heterogeneity, prompting a fixed effects modeling estimate. Otherwise, a random effects model was used.

Results

Literature search

Figure 1 shows a summary of the study selection process. A total of 1131 articles were identified through PubMed, EMBASE, and the Cochrane Library databases searches. After removal of duplicate and irrelevant articles by title and abstract review, ten potential articles were retrieved for further full text evaluation. Among them, two articles were excluded for not meeting the eligibility criteria. Finally, eight articles (three RCTs and five retrospective observational studies) with 582 patients finally were included in this meta-analysis [2, 3, 6, 7, 9, 15, 16, 21]. Table 1 summarizes the main characteristics of all included studies.

Risk of bias in the included studies

Figures 2 and 3 describe a summary of the risk of bias and the risk of bias according to each study, respectively. All included RCTs were rated as "low risk of bias" according to the Cochrane Back Review Group criteria. Only one RCT was blinded to both clinical personnel and participants [16].

Quality of evidence assessment

GRADE Pro version 3.6 was used to generate summary tables. The GRADE level of the evidence was low for Bishop score, visual analogue scale score reduction, hematoma rate and secondary surgical procedures rate; and moderate for scar tenderness/elbow pain and postoperative satisfaction. Among the five observational retrospective studies, the Newcastle–Ottawa Scale was used to assess the risk of bias. Bacle's [2] score was 6. Bolster's [3], Watts's [21] and Saint-Cyr's [15] scores also were 7. Dutzmann's [6] score was 9. All of the scores indicated a low risk of bias.

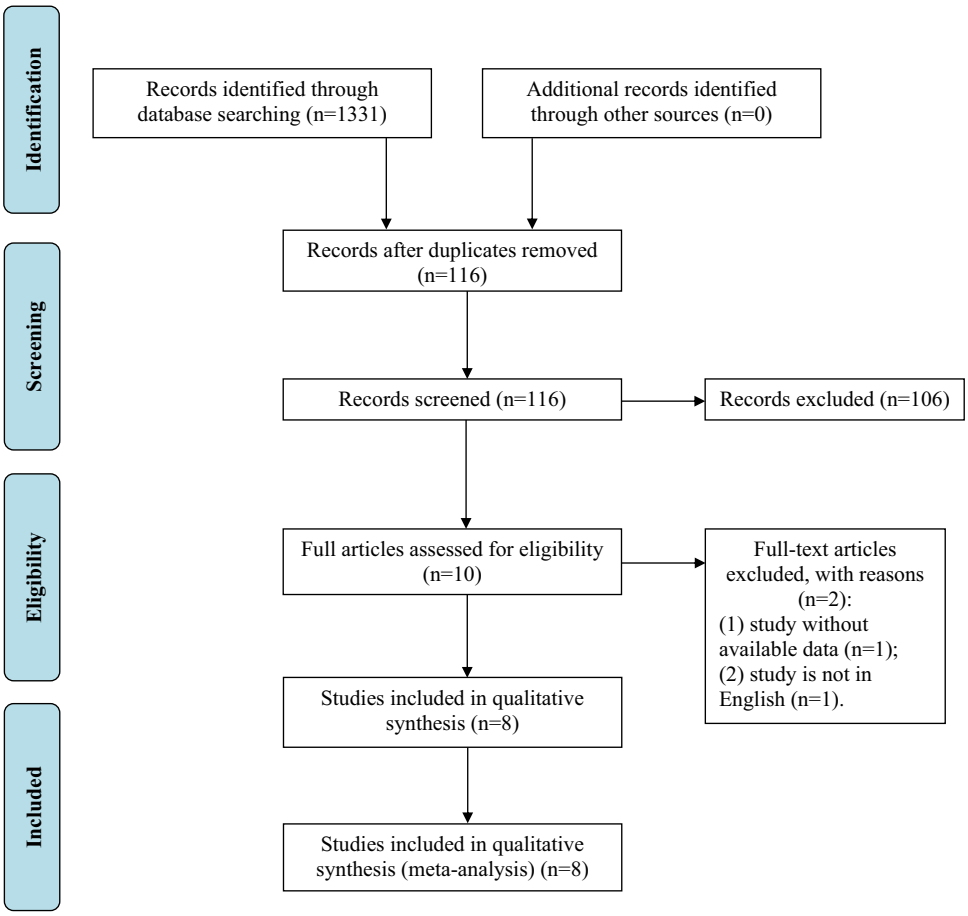

Fig. 1 Flow chart showing search strategy

Table 1 Characteristics of all included studies

Study	Years	Country	Design	Levels	Mean age (years)	Sample size (EISD/OISD)	Female (%)	Mean follow-up (months)
Bacle et al. [2]	2014	USA	Retrospective observational	4	55	143/48	43.2	94
Bolster et al. [3]	2014	The Netherlands	Retrospective observational	4	49.9	20/22	52.3	6
Dutzmann et al. [6]	2013	Germany	Retrospective observational	4	47.6	55/59	44.7	24
Heikenfeld et al. [7]	2013	Germany	RCT	1	–	15/15	–	12
Krejčí et al. [9]	2018	Czech Republic	RCT	1	54.6	22/23	51.1	12
Saint-Cyr et al. [15]	2013	USA	Retrospective observational	4	45.6	12/58	48.1	139.2
Schmidt et al. [16]	2015	Germany	RCT	1	49.2	29/27	43.2	24
Watts and Bain [21]	2009	Australia	Retrospective observational	4	44.9	19/15	44.1	12

RCT randomized controlled trial, *EISD* endoscopic in situ decompression, *OISD* open in situ decompression

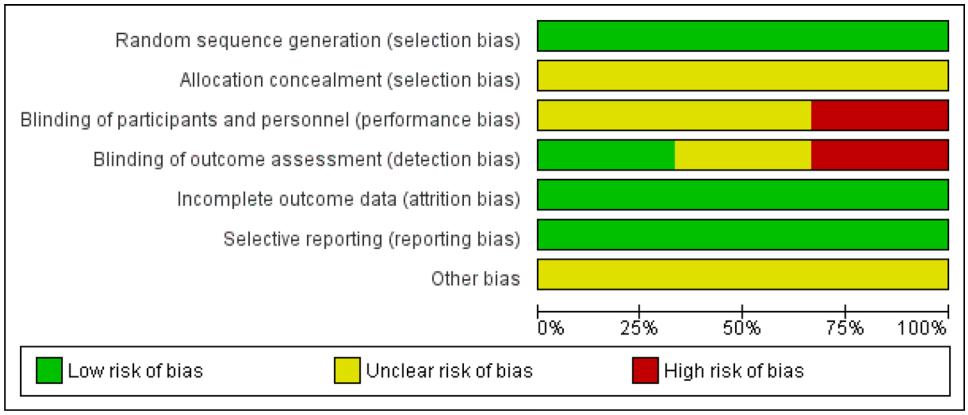

Fig. 2 Risk of bias summary

Outcome analysis

Bishop score

Five studies reported the Bishop score data [3, 6, 7, 9, 16]. Pooled results showed that patients who underwent EISD had a greater improvement in the Bishop score than did those who underwent OISD without statistical significance (RR = 0.96; 95% CI 0.85, 1.10; $p = 0.57$; $I^2 = 0\%$) (Fig. 4).

Visual analogue scale score reduction

Four studies reported changes in the visual analogue scale score reduction [3, 9, 16, 21]. Pooled analysis showed that the difference in visual analogue scale score reduction was not statistically significant between the EISD group and the OISD group (MD = − 0.32; 95% CI − 1.29, 0.66; $p = 0.52$; $I^2 = 89\%$) (Fig. 5).

Scar tenderness/elbow pain

Five studies reported the data of the scar tenderness/elbow pain [2, 6, 9, 16, 21]. Pooled results showed that patients who underwent EISD had a greater improvement in the scar tenderness/elbow pain than did those who underwent OISD with statistical significance (RR = 0.20; 95% CI 0.09, 0.45; $p = 0.0001$; $I^2 = 0\%$) (Fig. 6).

Postoperative satisfaction

Comparison of postoperative satisfaction with the results between EISD group and OISD group was conducted between the five included studies [2, 3, 9, 16, 21]. Pooled analysis showed that the postoperative satisfaction with the results did not have a significant difference between the studies (RR = 0.98; 95% CI 0.90, 1.07; $p = 0.68$; $I^2 = 0\%$) (Fig. 7).

Postoperative hematoma rate

Five studies reported the data of postoperative hematoma rate [2, 6, 9, 16, 21]. We observed similar overall rate of postoperative hematoma when comparing the EISD group with the OISD group (RR = 1.54; 95% CI 0.63, 3.77; $p = 0.34$; $I^2 = 58\%$) (Fig. 8).

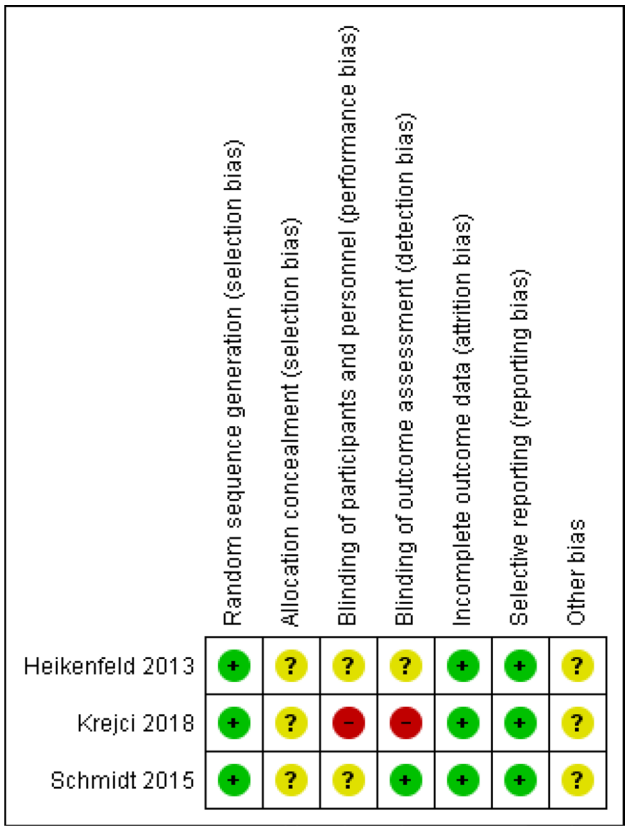

Fig. 3 Risk of bias for each study

Secondary surgical procedures rate

Four studies reported the rate of reoperation after EISD and OISD [6, 9, 16, 21]. We also observed similar overall rate of reoperation when comparing both surgical procedures (RR = 1.06; 95% CI 0.37, 3.02; $p = 0.91$; $I^2 = 4\%$) (Fig. 9).

Discussion

It's well known that the EISD to the cubital tunnel syndrome was introduced as a minimally invasive alternative for OISD of the ulnar nerve at the elbow, aiming to minimize the trauma to the tissues and improve postoperative recovery of the patients, with an even longer decompression of the ulnar nerve. Its theoretical advantages over the OISD are the faster recovery of the patient, decreased invasiveness, minimal adverse events and less scar discomfort [13]. The use of the EISD for surgical treatment of patients with cubital tunnel syndrome started in 1995 by Tsai et al. [20]. Although some current studies report excellent results with the EISD technique, it is still unclear whether this technique is really superior to the standard OISD technique.

The present meta-analysis identified 3 RCTs and 5 retrospective observational studies, investigating the effects of EISD and OISD in patients with cubital tunnel syndrome. Our meta-analysis showed that no significant differences in the primary outcomes were observed between the two comparison groups, both in RCTs and retrospective observational studies. However, our meta-analysis of scar tenderness/elbow pain yielded a different result, which the incidence of scar tenderness/elbow pain was significantly lower in EISD group than in OISD group. This may draw our attention to the need for further high-quality and adequately powered RCTs with standardized clinical outcomes metrics.

A systematic review and meta-analysis published in 2016 by Ren et al. [14] which offered a comparison of two surgical techniques found that EISD and OISD for treating cubital tunnel syndrome have equivalent efficacy for postoperative clinical improvement, whereas the incidences of

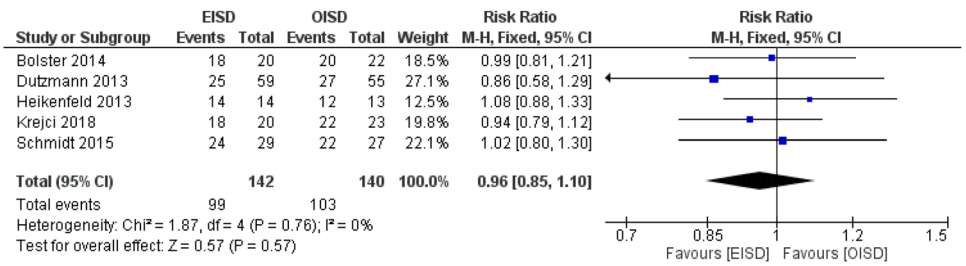

Fig. 4 Forest plot for Bishop score

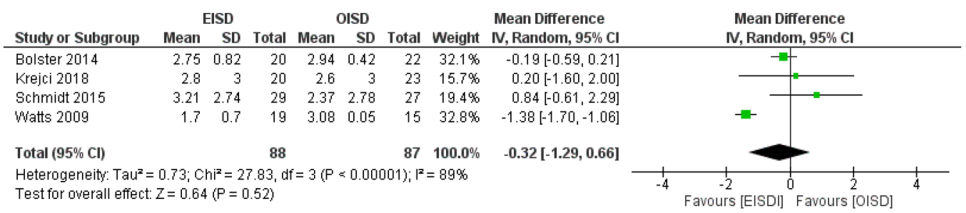

Fig. 5 Forest plot for visual analogue scale score reduction

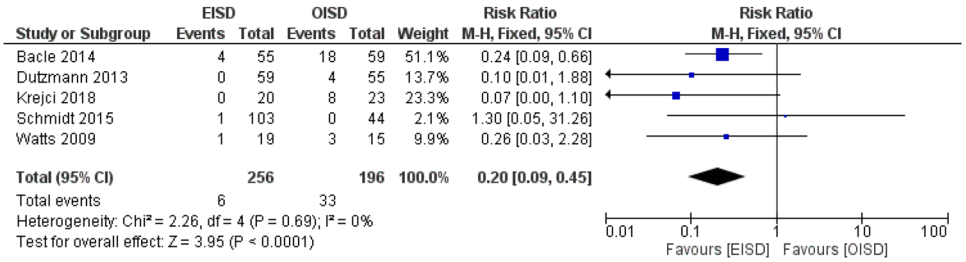

Fig. 6 Forest plot for scar tenderness/elbow pain

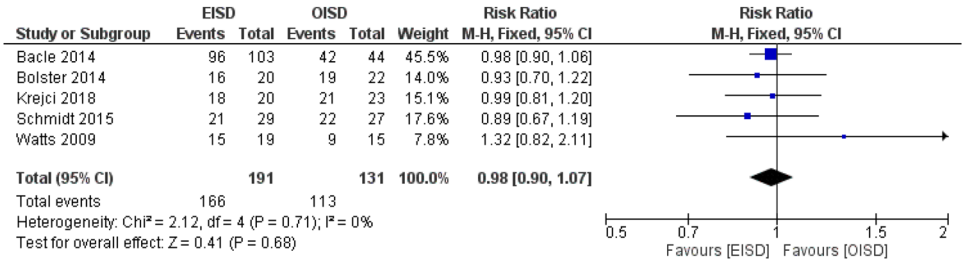

Fig. 7 Forest plot for postoperative satisfaction

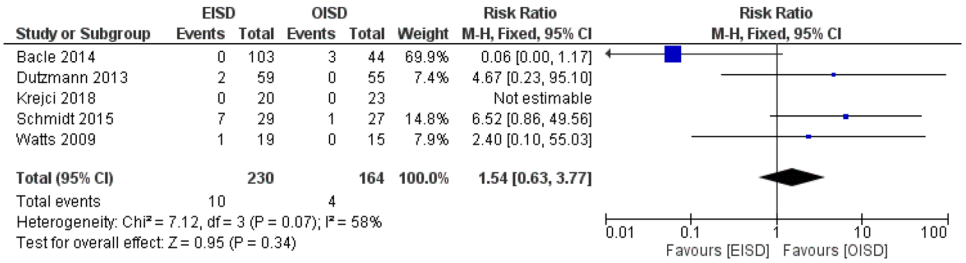

Fig. 8 Forest plot for hematoma rate

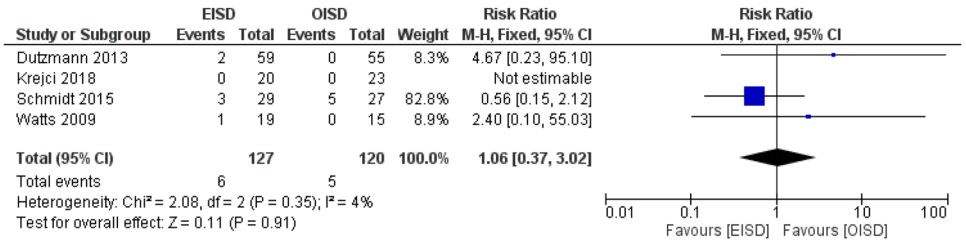

Fig. 9 Forest plot for secondary surgical procedures rate

complications of EISD were also same as those with the OISD. The authors consider that EISD could be treated as a valuable alternative to treat patients with cubital tunnel syndrome. Similar results were obtained in meta-analysis published in 2018 by Buchanan et al. [5]. Researchers have found equivalent overall clinical improvement between EISD and OISD in surgical treatment of cubital tunnel syndrome in terms of Bishop score and visual analogue scale score reduction.

Adverse events in the included studies should also be discussed in detail. Complications, such as hematoma in the surgical field, injury to the medial cutaneous nerves of the forearm, or injury to the ulnar nerve itself, were not noted in Krejčí's study [9]. Reoperation, for persistent or recurrent cubital tunnel syndrome, was also not recorded in this study. There was one postoperative wound infection in the EISD group in Bolster's study [3], which was successfully treated with antibiotics. Postoperative complications included pain or scar tenderness at the elbow that had not been reported preoperatively (4 patients), numbness around the elbow (3 patients), and need for further surgery were reported in Watt's study [21]. Postoperative hematomas (1 patients) and disturbance of wound healing (1 patients) in Schmidt's study [16] were also mentioned. EISD was associated with a painful scar at the end of follow-up in Bacle's study [2]. For the EIDS group, 2 patients with postoperative hematomas and 4 patients with signs of subluxation of the ulnar nerve were reported in Dützmann's study [6]. In conclusion,

the EISD group showed a same incidence of complications compared to the OISD group in line with our pooled results. Similar results were obtained in previous systematic reviews and meta-analyses [5, 14]. However, Toirac et al. [19] have clearly shown that there is a difference in clinical outcomes between two surgical groups, with EISD technique being superior in regard to both complication rates along with patient satisfaction.

The present meta-analysis is a comprehensive evaluation of current evidence, incorporating three RCTs and five retrospective observational studies, compare the efficacy of EISD and OISD techniques for the treatment of cubital tunnel syndrome in one report. We made our best effort to extract all available data from included studies and contacted the authors to provide further information, especially those without concrete outcomes data. In contrast to previous systematic reviews and meta-analysis, we examined the evidence from RCTs and observational studies, and incorporated GRADE approach to summarize evidence to make judgments about the overall quality for each outcome. To evaluate possible source of heterogeneity, we did predefined subgroup analyses. In addition, we also performed sensitivity analysis to assess the influence of each study on the overall pooled estimate. Nevertheless, some potential limitations in the present study should also be noted when interpreting the results.

Limitations

Many significant limitations exist of this meta-analysis. First, the major limitations are only a small number of RCTs directly comparing two surgical treatments and largely depend on retrospectively collected data, which are potentially subject to a high risk of selection bias. Second, there are no universally standardized metrics to assess clinically relevant improvement in function compared to baseline. Third, there are also differences in operative technique of EISD and OISD that can influence postoperative clinical curative effects.

Conclusion

This meta-analysis demonstrated that EISD and OISD for surgical treating cubital tunnel syndrome had equivalent efficacy regarding postoperative clinical recovery, whereas the incidences of adverse events of EISD were also same as those with the OISD technique. We consider that EISD technique should be applied in selected patients who do not have preoperative evidence of nerve subluxation, previous traumatic injuries to elbow, or obvious anatomical pathology. Current evidence lacks data to draw rigorous conclusion on objective outcome measures, return to work, and cost–benefit analyses. Further RCTs implementing standardized classification systems and objective outcome measures are required.

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Compliance with ethical standards

Conflict of interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

Informed consent For this type of study, formal consent is not required.

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