Endoscopic decompression of the ulnar nerve in the cubital tunnel yields similar outcomes but a lower complication rate than open decompression: a systematic review and meta-analysis

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ABSTRACT
Importance Cubital tunnel syndrome is the second most common peripheral nerve compression syndrome in the USA. There is controversy in the literature regarding the best surgical option.

Objective The purpose of this investigation was to perform a systematic review to determine if there is a difference in clinical outcomes or complications between open and endoscopic cubital tunnel release in patients with compression of the ulnar nerve in the cubital tunnel.

Evidence review A systematic review was registered with PROSPERO and performed using PRISMA guidelines. PubMed, SCOPUS, and Cochrane Central Register of Controlled Trials databases were searched for level I–IV therapeutic comparative studies of open versus endoscopic cubital tunnel decompression in adult human patients. The levels of evidence were then assigned based on the Oxford Centre for Evidence-Based Medicine. Study methodological quality was analysed using the Modified Coleman Methodology Score. Only the outcome measurements that 3 or more studies used were included in our data synthesis. Postoperative patient satisfaction, Bishop score, recurrence and complication rates were compared between the endoscopic and open groups using the χ² test using p<0.05.

Findings Six articles (507 patients, mean age of 48.2 years, with 28.8 months average follow-up) were analysed. 76.1% of patients were satisfied in the endoscopic group, and 73.8% were satisfied in the open group (p=0.7023). 87.4% of endoscopic patients and 81.2% of open patients had a Bishop score of excellent or good (p=0.236). The endoscopic group had a recurrence rate of 1.1%, and the open group had a 3.5% recurrence rate (p=0.0872). There were significantly fewer complications in the endoscopic group (7.9%) compared to the open group (12.9%) (p<0.01).

Conclusions and relevance Equivalent clinical outcomes, patient satisfaction and recurrence rates were observed between open and endoscopic techniques. However, a significantly lower complication rate was observed with the endoscopic technique.

Level of evidence Level IV, systematic review of level I–IV studies.

INTRODUCTION
Cubital tunnel syndrome is a compressive neuropathy of the ulnar nerve at the elbow. It is the second most common peripheral nerve compression syndrome with an incidence of 75,000 cases per year.1–3 It often presents in the advanced stages of the disease with decreased sensation and muscle atrophy that can have permanent deficits if left untreated.4

Surgical treatment is reserved for patients with persistent symptoms that have failed non-surgical (life-style modification and immobilisation) management. Historically, there have been three commonly used open surgical techniques for the treatment of cubital tunnel syndrome: in-situ decompression, anterior transposition (submuscular, subcutaneous) and medial epicondylectomy. Recent randomised controlled trials and meta-analyses have demonstrated similar outcomes between these techniques.5–10

More recently, endoscopic decompression of the ulnar has been suggested to improve recovery.11–12 There has been no clear consensus comparing open and endoscopic techniques with regard to patient-reported clinical outcomes and complication rates.

The availability and effectiveness of multiple techniques has led to controversy in the literature regarding the best surgical option for the treatment of cubital tunnel syndrome. The purpose of this investigation was to determine if there is a difference in clinical outcomes or complications between open and endoscopic cubital tunnel release in patients with compression of the ulnar nerve in the...
cubital tunnel. The authors hypothesised that there would be no significant differences in clinical outcomes or complications.

METHODS
The systematic review was registered with PROSPERO on 21 March 2016 (registration number CRD42016036721). Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) guidelines were followed.13 Eligible studies consisted of level I–III studies published in the English language that compared the outcomes of open versus endoscopic cubital tunnel decompression in adult human patients. Studies that only reported one technique (either open or endoscopic) were excluded. Cadaveric studies, prognostic studies, economic studies, diagnostic studies, level V evidence expert opinion, letters to editors, review articles and revision decompression were excluded. In the event of different studies with duplicate participant populations, the study with longer follow-up, higher level of evidence, greater number of participants or greater clarity of methods and results was included.

The authors conducted separate searches of the following medical databases: PubMed, SCOPUS and Cochrane Central Register of Controlled Trials. The searches were performed on 10 March 2016. The search terms used were ‘cubital tunnel’, ‘ulnar neuropathy’, ‘ulnar nerve entrapment’ and ‘decompression’. An example of the search strategy used for PubMed can be found in the footnote.1 The search results were reviewed for duplicates and the inclusion criteria to determine articles that were included in the final analysis (figure 1).

Two authors independently reviewed all articles using the methodology recommended by Harris et al.14 The study design, patient populations and surgical technique were first identified. Patient-reported outcomes, Bishop score, recurrence rates and complication rates were analysed. Complication was variably defined across studies. Complications included but were not limited to damage to the median antebrachial cutaneous nerve (MABCN), haematoma, infection, persistent pain or any need for reoperation.

The levels of evidence were then assigned based on the Oxford Centre for Evidence-Based Medicine.15 Study methodological quality was analysed using the Modified Coleman Methodology Score (MCMS).16 According to the MCMS, two articles were good (scores between 70 and 84), three were fair (scores between 55 and 69) and one was poor (scores < or equal to 54) with an average score of 64.5.

Owing to the heterogeneity of outcome measures, a best-evidence synthesis17 was used when possible. Only the outcome measurements that three or more studies used were included in our data synthesis. Postoperative patient satisfaction, Bishop score, recurrence and complication rates were compared between the endoscopic and open groups using the χ² test (http://in-silico.net/tools/statistics/chi2test) using p<0.05.

RESULTS
Six articles were analysed (table 1).18–23 One article was level II,23 and the remaining studies were level III evidence.18–22 There were a total 507 participants analysed (278 endoscopic; 229 open). The mean age in the endoscopic group was 49.8 (±4.3) with a mean follow-up of 28.6 (±31.3) months, and the average age in the open group was 46.6 (±6.0) with an average follow-up of 29.0 (±32.6) months.

All studies preoperatively confirmed the presence of ulnar nerve compression at the elbow using electromyography (EMG) or clinical findings. The endoscopic group had 99.6% of patients, and the open group had 98.3% of patients with confirmation of cubital tunnel syndrome via EMG. Four studies assessed the severity of the cubital tunnel syndrome using the McGowan-Goldberg grade. In the endoscopic group, 32.0% were grade I, 41.9% grade II and 26.1% grade III. In the open group, 18.1% were grade I, 46.0% grade II and 35.9% grade III. The Bishop score was the most frequently used outcome measurement (four of six studies). Subjective patient satisfaction was used in 3 of 6, Visual Analogue Scale (VAS) was used in 2 of 6 and 5 of 6 studies recorded recurrence and complication rates (table 2).

There was no statistically significant difference in self-reported patient satisfaction between the endoscopic and open groups. The endoscopic group had 76.1% of patients satisfied and 73.8% were satisfied in the open group at final follow-up (p=0.70). The endoscopic group had 87.4%, and the open group had 81.2% of patients with a Bishop score of excellent or good (p=0.24). The endoscopic group had a recurrence rate of 1.1%, and the open group had a 3.5% recurrence rate (p=0.09). There were significantly fewer complications in the endoscopic group (21/266, 7.9%) compared to the open group (27/171, 15.8%) favouring endoscopic over open decompression of the ulnar nerve at the elbow (p<0.01) (table 3).

There were 10 postoperative haematomas requiring decompression, 4 cases of ulnar nerve subluxation requiring reoperation for transposition, 3 cases of delayed wound healing, 2 cases of persistent elbow scar pain, 1 intraoperative conversion to open decompression secondary to adhesions and 1 infection in the endoscopic group. The open group had 17 patients with numbness around the elbow attributed to injury to the MABCN, 7 with persistent elbow scar pain, 1 case of infection, 1 delayed wound healing and 1 postoperative haematoma requiring decompression (table 2).

DISCUSSION
It was determined that equivalent clinical outcomes, patient satisfaction and recurrence rates occurred between open and endoscopic techniques. However, there was a significantly lower complication rate with the endoscopic technique compared to the open technique. This study confirmed the authors’ hypothesis that there would be no significant differences in clinical outcomes between the groups, but rejected the hypothesis that endoscopic and open techniques would result in equivalent complication rates.

The availability of multiple techniques has led to controversy regarding the best surgical option for the treatment of cubital tunnel syndrome. The most common site of compression in the cubital tunnel is below Osborne’s ligament leading some authors to favour simple open decompression.24 However, as the elbow flexes, the cross-sectional area of the cubital tunnel decreases and the intraneurial pressure exceeds the extraneurial pressure in the cubital tunnel indicating a possible tension
component to cubital tunnel syndrome and the need for anterior transposition of the ulnar nerve. Recent randomised control trials and meta-analyses have demonstrated similar outcomes between these techniques leading to the investigation of more minimally invasive and endoscopic decompression of the ulnar nerve in the cubital tunnel.

There is limited data on patient-reported outcomes following simple open decompression of the cubital tunnel. Prior studies, one regarding open medial epicondylectomy and one involving submuscular transposition, have reported patient satisfaction of 83% and 95%, respectively. This is higher than the self-reported outcomes in the present review with 76.1% of patients satisfied in the endoscopic group and 73.8% satisfied in the open group at final follow-up. Although the endoscopic group had higher patient satisfaction, the difference was not statistically significant.

The Bishop score is used to evaluate postoperative outcomes following cubital tunnel decompression. This scale includes information regarding improvement in symptomatology, work status, leisure activities, strength and sensibility. Previous studies have found excellent or good outcomes in 81–91% patients undergoing endoscopic decompressions and 65–80% in patients with simple...
The present study had similar results with 87.4% and 81.2% of patients in the endoscopic and open groups, respectively, having a Bishop score of excellent or good. Despite its widespread use, the Bishop score has not been tested for validity and reproducibility similar to most outcome measures used to evaluate cubital tunnel procedures. In the present study, the endoscopic group had a recurrence rate of 1.1% and the open group had a 3.5% recurrence rate. Dellon et al.35 suggested persistent tension on the nerve during elbow flexion and nerve irritability secondary to hypermobility as potential causes of recurrence or continuation of symptoms. Our data are similar to studies by Song et al.36 and Gaspar et al.37 in which 1 of 39 (2.6%) and 7 of 216 (3.2%) patients, respectively, underwent revision decompression for recurrence.

The most commonly reported complications following ulnar nerve decompression at the elbow include continuation of symptoms, damage to the medial antebrachial cutaneous nerve, ulnar nerve subluxation, scar tenderness, haematoma formation and recurrence.38 The current study had significantly fewer complications in the endoscopic group (7.9%) compared to the open group (12.9%) (p<0.01). The most common complications in the open group were numbness around the elbow attributed to injury to the MABCN and persistent elbow scar pain. Damage to the MABCN is a well-documented complication in open decompression as anatomic studies have routinely demonstrated the proximity of the posterior branch to the surgical incision.39 The most common complications in the endoscopic group were postoperative haematomas and ulnar nerve

| Table 2 Individual study outcome measures |
|-------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Bolster et al 201418          | Bacle et al 201419  | Watts et al 200920  | Saint-Cyr et al 201321 | Dützman et al 201322 | Schmidt et al 201523 |
| Patient satisfaction         |                     |                     |                     |                     |                     |
| Endoscopic                   | 16/20 Satisfied      | Cured: 77           | Improved: 19        | Unchanged: 7        | Worsened: 0         |
|                              |                     | 15/19 Satisfied     | NR                  | NR                  | NR                  |
| Open                         | 19/22 Satisfied      | Cured: 31           | Improved: 11        | Unchanged: 1        | Worsened: 0         |
|                              |                     | 9/15 Satisfied      | NR                  | NR                  | NR                  |
| Length of surgery            | Endoscopic          | 41.5                | NR                  | NR                  | NR                  |
|                              | Open                | 32.4                | NR                  | NR                  | NR                  |
| Bishop score                 | Endo post           | 8/11 Excellent      | 2/11 Good           | 1/11 Fair           | 0/11 Poor           |
|                              |                     | 3/11 Satisfied      | 1/11 Good           | 0/11 Poor           | 0/11 Poor           |
|                              |                     | 8.75 (Excellent)    | 3/11 Satisfied      | 1/11 Good           | 0/11 Poor           |
|                              |                     | 7/11 Satisfied      | 1/11 Good           | 0/11 Poor           | 0/11 Poor           |
|                              |                     | 4/11 Satisfied      | 1/11 Good           | 0/11 Poor           | 0/11 Poor           |
|                              |                     | 2/11 Good           | 1/11 Fair           | 0/11 Poor           | 0/11 Poor           |
|                              |                     | 19/27 Excellent     | 7/27 Good           | 2/27 Poor           | 0/27 Poor           |
|                              |                     | 25/26 Excellent     | 15/25 Good          | 5/25 Poor           | 0/25 Poor           |
|                              |                     | 21/21 Excellent     | 10/20 Good          | 4/20 Poor           | 0/20 Poor           |
|                              |                     | 17/17 Excellent     | 8/17 Good           | 2/17 Poor           | 0/17 Poor           |
|                              |                     | 13/13 Excellent     | 6/13 Good           | 1/13 Poor           | 0/13 Poor           |
| McGowan-Goldberg grade       |                     |                     |                     |                     |                     |
|                              |                     | III: 8             | NR                  | NR                  | NR                  |
| Endo post                    | NR                  | 0: 83, I: 15,      | I: 4, II: 6, III: 5 | NR                  | I: 8, II: 16, III: 35| I: 1, II: 15, III: 11 |
|                              |                     | II: 5, III: 0      | NR                  | NR                  | NR                  |
| Open pre                     | NR                  | I: 20, II: 53,     | I: 10, II: 5, III: 4| NR                  | I: 7, II: 15, III: 33| I: 0, II: 21, III: 8 |
|                              |                     | III: 27            | NR                  | NR                  | NR                  |
| Open post                    | NR                  | 0: 31, I: 6, II: 6,| I: 10, II: 5, III: 4| NR                  | I: 8, II: 16, III: 35| I: 1, II: 15, III: 11 |
|                              |                     | III: 0             | NR                  | NR                  | NR                  |
|                              |                     | 91                 | NR                  | NR                  | NR                  |
|                              |                     | 94                 | NR                  | NR                  | NR                  |
|                              |                     | 93                 | NR                  | NR                  | NR                  |
| Recurrence                   | Endoscopic          | 0                  | 0                   | 1                  | 0                   |
|                              | Open                | 0                  | 0                   | 0                  | 0                   |
| Complications                | Endoscopic          | Infection (1)      | Conversion to open (1), painful scar (1), haematoma (1) | NR | Haematomas (2), subluxation of ulnar nerve (4) | Haematomas (7), delayed wound healing (3) |
|                              | Open                | 0                  | Painful scar (3), MABCN injury (3) | NR | MABCN injury (14), painful scar (4), infection (1) | Haematoma (1), delayed wound healing (1) |

MABCN, Medial antebrachial cutaneous nerve; NAS, Numerical Analogue Scale; NR, not recorded; VAS, Visual Analogue Scale.
subluxation. This incidence of haematoma formation following endoscopic decompression (3.8%) was similar to a prior study by Martin et al. in which 4.3% patients developed a post-operative haematoma.

There are several limitations and biases noted among the studies included in this review. With the exception of one article that was level II, the remaining articles were level III evidence. The low level of studies included in this review limits the strength of the conclusions. The study methodological quality as assessed by the MCMS was fair on average. The Bishop score and McGowan-Goldberg grade are the best outcome scores for cubital tunnel. Future studies can improve through designing a prospective comparative trial, increasing study size and standardising clinical outcome measures such as using the Bishop score and McGowan-Goldberg grade simultaneously. The number of studies (n=6) included in this review is small. Another possible limitation of this review is that other relevant studies on this topic could have been excluded, despite conducting a systematic search. As we found many duplicate studies, we do not feel that many, if any, were omitted during our literature search.

CONCLUSIONS

In this meta-analysis analysing patients with cubital tunnel syndrome, equivalent clinical outcomes, patient satisfaction and recurrence rates were observed between open and endoscopic techniques. However, a significantly lower complication rate was observed with the endoscopic technique.

Contributors All the authors have been actively involved in the planning and enactment of the study and have also assisted with the preparation of the submitted article. The manuscript has been read and approved by all authors.

Competing interests KRS, DTB and SRL declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article. JDH has the following disclosures: AADS: Board or committee member; American Orthopaedic Society for Sports Medicine: Board or committee member; Arthroscore: Editorial or governing board; Arthroscopy Association of North America: Board or committee member; DePuy, A Johnson and Johnson Company: research support; Frontiers in Surgery: Editorial or governing board; NIA Magellan: paid consultant; SLACK Incorporated: publishing royalties, financial or material support; Smith and Nephew: paid presenter or speaker and research support.

Provenance and peer review Commissioned; externally peer reviewed.

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Systematic review

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*J ISAKOS* 2017 2: 8-13 originally published online November 15, 2016
doi: 10.1136/jisakos-2016-000112