Endoscopic versus Open In Situ Cubital Tunnel Release: A Systematic Review of the Literature and Meta-Analysis of 655 Patients

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Background: Cubital tunnel syndrome is the second most common peripheral entrapment syndrome. To date, there is no true consensus on the ideal surgical management. A minimally invasive, endoscopic approach has gained popularity but has not been adequately compared to the more traditional, open approach.

Methods: With compliance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a systematic review was performed to identify studies published between 1990 and 2016 that compared the efficacy of endoscopic cubital tunnel release to open cubital tunnel release. A meta-analysis was then performed through a random-effects model with inverse variance weighting to calculate I^2 values for heterogeneity analysis. Forest plots were constructed for each analysis group.

Results: Five studies involving 655 patients (endoscopic cubital tunnel release, $n = 226$; open cubital tunnel release, $n = 429$) were included. Meta-analysis revealed no significant superiority of open release in achieving an "excellent" or "good" Bishop score (OR, 1.27; 95 percent CI, 0.59 to 2.75; $p = 0.54$) and reduction in visual analogue scale score (mean difference, −0.41; 95 percent CI, −1.49 to 0.67; $p = 0.46$). However, in the endoscopic release cohort, lower rates of new-onset scar tenderness/elbow pain were found (OR, 0.19; 95 percent CI, 0.07 to 0.53; $p = 0.002$), but there was a higher incidence of postoperative hematomas (OR, 5.70; 95 percent CI, 1.20 to 27.03; $p = 0.03$). The reoperation rate in the endoscopic and open release groups was 4.9 and 4.1 percent, respectively ($p = 0.90$).

Conclusions: The authors demonstrated equivalent overall clinical improvement between endoscopic and open cubital tunnel release in terms of Bishop score and visual analogue scale score reduction. Because of the low power of most studies, further investigations with a larger patient population and longer follow-up are needed to better characterize the role of endoscopic cubital tunnel release. (*Plast. Reconstr. Surg.* 141: 679, 2018.)

Cubital tunnel syndrome is the second most common peripheral neuropathy, with an annual reported incidence of 24.7 per 100,000.[1] Although nonsurgical management is recommended in the majority of these cases, 42 percent of patients eventually require surgical release.[2] There are two surgical approaches for ulnar nerve decompression: endoscopic and open.[3] First described in 1999, the endoscopic approach has demonstrated a more favorable clinical outcome in the literature.[4] Endoscopic peripheral nerve releases are associated with decreased patient-reported pain levels, decreased incisional tenderness, and an expedited recovery time.[5–7] However, the reported concerns for such an approach are linked to its increased technical learning curve and the potential risk of injury to the ulnar and other cutaneous nerves. Despite

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these potential drawbacks, the popularity of endoscopic ulnar nerve release continues to grow, likely stemming from patient desire for smaller scars and quicker recoveries.

The aim of this study was to analyze previously published studies evaluating and comparing open, in situ, versus endoscopic cubital tunnel release. Clinical measures such as Bishop score, visual analogue scale score, rate of reoperation, and pain/scar tenderness were collected from these previously published studies to investigate their relative effectiveness in the surgical management of cubital tunnel syndrome.

METHODS

Study Selection

Maintaining compliance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, three reviewers (P.J.B., L.O.C., and Z.H.) conducted a systematic literature search in the MEDLINE, EMBASE, and Cochrane Central Register of Controlled Trial databases. All articles published between 1990 and 2016, with English as the primary language, were identified. A combination of the following Medical Subject Headings terms were used to conduct the search: "endoscopic decompression," "open decompression," "in-situ decompression," "simple decompression," "arthroscopic," "cubital tunnel syndrome," "ulnar nerve entrapment," "ulnar neuropathy," and "ulnar nerve compression syndrome." The three reviewers (P.J.B., L.O.C., and Z.H.) independently performed each step in the study-selection process. Cross-referencing initial articles found by means of the initial keyword searches allowed for the identification of additional articles. Ambiguous articles were sent to the senior author (H.C.) for final determination for inclusion. Articles were included if they met the following criteria: (1) comparative retrospective studies, prospective reports, and clinical trials that reported clinical outcome parameters following either endoscopic cubital tunnel release or open cubital tunnel release; (2) reported cases without prior history of trauma and/or surgery on the affected arm; and (3) contained 40 cases or more within the study. Case reports, review articles, cadaveric studies, editorials, commentaries, and single-arm studies were excluded.

Data Extraction

From the included studies, the three reviewers (P.J.B., L.O.C., and Z.H.) independently assessed the quality and methodology of each study meeting the inclusion criteria. These articles were then further analyzed looking at patient population, interventions, and associated outcome/complications. Baseline data including age, sex, population size, baseline severity, and follow-up time period for each study were collected. The level of evidence for each article was assessed using the standardized reporting scheme provided by the Oxford Centre for Evidence-Based Medicine. The study quality (i.e., risk bias evaluation) was assessed using the Jadad score, which is a five-point quality score rating. Primary outcome data were collected by means of the Bishop score, the McGowan scale, and the visual analogue scale. Secondary outcome measures included complication rates.

Meta-Analysis

The aforementioned baseline data were analyzed using IBM SPSS Version 22.0 software (IBM Corp., Armonk, N.Y.). Results were stratified into two groups, endoscopic and open cubital tunnel release, and presented as mean ± SD. When standard deviations were not available, the method described by Hozo et al. was used to estimate this value using other provided statistical information such as range, mean, and median.[8] Odds ratio with a 95 percent confidence interval were used for each outcome variable. A random effects model with inverse variance weighting to calculate I^2 values was performed if heterogeneity testing between study variability was greater than 50 percent. Forest plots were constructed for each group. Publication bias was presented graphically using a funnel plot and Egger regression test. These statistical analyses were performed using RevMan version 5.0 (Nordic Cochrane Centre, Copenhagen, Denmark).

RESULTS

Search Results

Initial systematic search of the MEDLINE, EMBASE, and Cochrane Central Register of Controlled Trial databases using the aforementioned keywords yielded 129 articles. After the selection process using the inclusion and exclusion criteria detailed above, five studies were deemed eligible for inclusion in our analysis. These five studies were composed of one randomized controlled trial, one retrospective multicenter cohort study, and three retrospective cohort studies. Table 1 summarizes the Jadad score and Oxford Centre for Evidence-Based Medicine level of evidence for each included article.[7,9–12]

Table 1. Study Design, Jadad Score, and Oxford Centre for Evidence-Based Medicine Level of Evidence for the Included Studies

Reference	Study Design	Jadad Score (Quality Rating)	OCEBM Scale (Level of Evidence)
Schmidt et al., 2015[9]	Prospective, randomized, double-blind	5 (high-range quality score)	Ib
Bacle et al., 2014[10]	Multicenter retrospective cohort	0 (low-range quality score)	IV
Bolster et al., 2014[11]	Retrospective cohort	0 (low-range quality score)	IV
Dutzmann et al., 2013[12]	Retrospective cohort	0 (low-range quality score)	IV
Watts and Bain, 2009[7]	Retrospective cohort	0 (low-range quality score)	IV

OCEBM, Oxford Centre for Evidence-Based Medicine.

Baseline Characteristics

These five included studies had 655 combined cubital tunnel releases, 226 (34.5 percent) by means of an endoscopic approach and 429 (65.5 percent) by means of an open approach. The mean age for patients undergoing endoscopic cubital tunnel release in all five studies was 49.84 years and 47.76 years in those undergoing open cubital tunnel release. One study did not stratify for sex in each group; however, using the data from the other four studies revealed 68 men (55.3 percent) and 55 women (44.7 percent) in the endoscopic groups. The open cubital tunnel release groups had 67 men (54.5 percent) and 56 women (45.5 percent). Baseline severity was measured using the McGowan classification score.[13] Pooled data from all five studies showed that in the endoscopic cubital tunnel release group, 77 (34.1 percent) had a McGowan I classification, 93 (41.1 percent) had a McGowan II classification, and 56 (24.8 percent) had a McGowan III classification. The pooled open cubital tunnel release groups contained 142 patients (33.1 percent) classified as McGowan I, 183 patients (42.7 percent) classified as McGowan II, and 104 patients (24.2 percent) classified as McGowan III. The mean follow-up for all included studies was 27.6 months.

Comparisons of Outcome Parameters

Three of the five included studies used the modified Bishop score to evaluate postoperative results.[14] Pooled data for the endoscopic cubital tunnel release group revealed an excellent Bishop score for 66 patients (63.5 percent), a good Bishop score for 22 patients (21.2 percent), a fair Bishop score for 11 patients (10.6 percent), and a poor Bishop score for five patients (4.8 percent). The open cubital tunnel release group had 64 patients (63.4 percent) with an excellent Bishop score, 18 patients (17.8 percent) with a good Bishop score, 13 patients (12.9 percent) with a fair Bishop score, and six patients (5.9 percent) with a poor Bishop score. Meta-analysis revealed no statistically significant superiority of open cubital tunnel release in achieving an excellent or good Bishop score compared with endoscopic cubital tunnel release (OR, 1.27; 95 percent CI, 0.59 to 2.75; $p = 0.54$) (Fig. 1). Likewise, no statistically significant mean reduction in visual analogue scale score was seen between open cubital tunnel release and endoscopic cubital tunnel release (mean difference, −0.41; 95 percent CI, −1.49 to 0.67; $p = 0.46$) (Fig. 2). This shows that the patients in both groups were equally satisfied in their symptom resolution.

Endoscopic Surgical Technique

A wide variety of brands were used based on the five included studies. Schmidt et al. used the retractor-integrated endoscope (Karl Storz GmbH & Co. KG, Tuttlingen, Germany). To keep this study blinded, they used a similar incision to their open approach consisting of a 3-cm longitudinal skin incision followed by direct fascial incision of the Osborne ligament. The endoscope was then inserted and all fibrous bands covering the ulnar nerve were cut. In this article, the tourniquet was deflated and hemostasis achieved before skin closure.[9] Unfortunately, the article by Bacle et al. did not describe the type or brand of endoscope used or their use of tourniquet or skin closure.[10] Bolster et al. used a 30-degree endoscope according to the Hoffman technique. A high-arm tourniquet was inflated; however, the article does not make mention of whether or not the tourniquet was deflated before closure.[11] Dutzmann et al. also used a tourniquet and inflated to 80 to 120 mmHg above the intraoperative systolic pressure. They also used the retractor-integrated endoscope and transected the fibrous bands overlying the ulnar nerve. There was no mention of whether or not the tourniquet was deflated before skin closure.[12] Watts and Bain used the Agee device to perform their endoscopic ulnar nerve release. Unfortunately, no further information was provided regarding use of tourniquet or skin closure.[7]

Rate of Complications

The five included studies were analyzed looking at patient-reported postoperative scar tenderness, hematoma rate, and rate of reoperation. After meta-analysis, a statistically significant reduction in patient-reported scar tenderness was found within the endoscopic cubital tunnel release cohorts ($p = 0.002$) (Fig. 3). However, endoscopic cubital tunnel release caused a statistically significant increase in postoperative hematoma rate ($p = 0.003$) (Fig. 4). The rates of reoperation for endoscopic and open cubital tunnel release were 4.9 and 4.1 percent, respectively ($p = 0.90$) (Fig. 5). The primary reasons for reoperation in the endoscopic cubital tunnel release cohort were hematoma (50 percent) and persistent/recurrent symptoms (50 percent). The primary reason for reoperation in the open cubital tunnel release cohort was persistent/recurrent symptoms (100 percent).

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Bolster, 2014	10	20	14	22	0.0%	0.57 [0.17, 1.96]
Dutzmann, 2013	49	59	43	55	68.2%	1.37 [0.54, 3.48]
Schmidt, 2015	24	29	22	27	31.8%	1.09 [0.28, 4.28]
Total (95% CI)		**88**		**82**	**100.0%**	**1.27 [0.59, 2.75]**
Total events	73		65			

Heterogeneity: Tau² = 0.00; Chi² = 0.07, df = 1 (P = 0.79); I² = 0%
Test for overall effect: Z = 0.61 (P = 0.54)

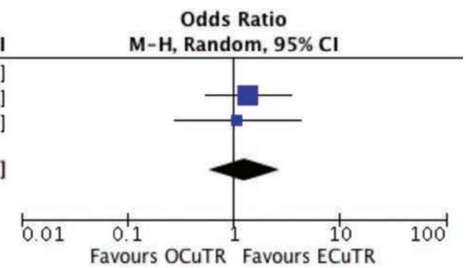

Fig. 1. Statistical analysis of Bishop scores comparing endoscopic (*ECuTR*) and open cubital tunnel release (*OCuTR*) at the last documented patient postoperative follow-up. *M-H*, Mantel-Haenszel.

Study or Subgroup	ECuTR Mean	ECuTR SD	ECuTR Total	OCuTR Mean	OCuTR SD	OCuTR Total	Weight	Mean Difference IV, Random, 95% CI
Bolster, 2014	2.75	0.82	20	2.94	0.42	22	38.0%	−0.19 [−0.59, 0.21]
Schmidt, 2015	3.21	2.74	29	2.37	2.78	27	23.3%	0.84 [−0.61, 2.29]
Watts, 2009	1.7	0.7	19	3.08	0.05	15	38.7%	−1.38 [−1.70, −1.06]
Total (95% CI)			**68**			**64**	**100.0%**	**−0.41 [−1.49, 0.67]**

Heterogeneity: Tau² = 0.76; Chi² = 26.49, df = 2 (P < 0.00001); I² = 92%
Test for overall effect: Z = 0.75 (P = 0.46)

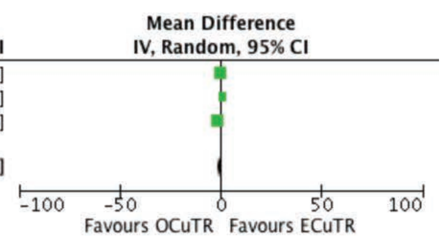

Fig. 2. Statistical analysis of visual analogue scale score reduction comparing endoscopic (*ECuTR*) and open cubital tunnel release (*OCuTR*) at the last documented patient postoperative follow-up.

Study or Subgroup	ECuTR Events	ECuTR Total	OCuTR Events	OCuTR Total	Weight	Odds Ratio M-H, Random, 95% CI
Schmidt, 2015	4	55	18	59	80.8%	0.18 [0.06, 0.57]
Watts, 2009	1	19	3	15	19.2%	0.22 [0.02, 2.40]
Total (95% CI)		**74**		**74**	**100.0%**	**0.19 [0.07, 0.53]**
Total events	5		21			

Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.87); I² = 0%
Test for overall effect: Z = 3.16 (P = 0.002)

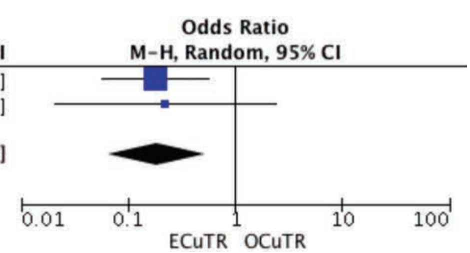

Fig. 3. Statistical analysis of scar tenderness/elbow pain comparing endoscopic (*ECuTR*) and open cubital tunnel release (*OCuTR*) at the last documented patient postoperative follow-up. *M-H*, Mantel-Haenszel.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Dutzmann, 2013	2	55	0	59	25.9%	5.56 [0.26, 118.45]
Schmidt, 2015	7	29	1	27	51.4%	8.27 [0.94, 72.52]
Watts, 2009	1	19	0	15	22.7%	2.51 [0.10, 66.20]
Total (95% CI)		**103**		**101**	**100.0%**	**5.70 [1.20, 27.03]**
Total events	10		1			

Heterogeneity: Tau² = 0.00; Chi² = 0.36, df = 2 (P = 0.84); I² = 0%
Test for overall effect: Z = 2.19 (P = 0.03)

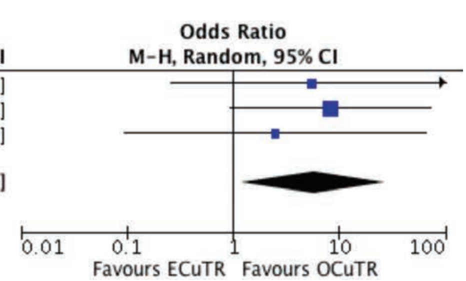

Fig. 4. Statistical analysis comparing endoscopic (*ECuTR*) and open cubital tunnel release (*OCuTR*) postoperative hematoma rate. *M-H*, Mantel-Haenszel.

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Dutzmann, 2013	2	55	0	59	20.1%	5.56 [0.26, 118.45]
Schmidt, 2015	3	29	5	27	62.1%	0.51 [0.11, 2.37]
Watts, 2009	1	19	0	15	17.8%	2.51 [0.10, 66.20]
Total (95% CI)		**103**		**101**	**100.0%**	**1.09 [0.26, 4.61]**
Total events	6		5			

Heterogeneity: $Tau^2 = 0.25$; $Chi^2 = 2.30$, df = 2 (P = 0.32); $I^2 = 13\%$
Test for overall effect: Z = 0.12 (P = 0.90)

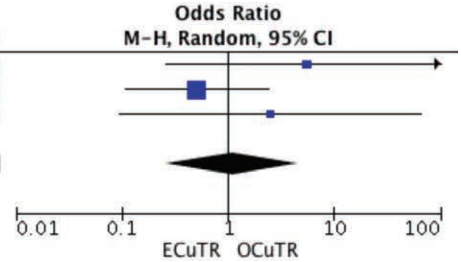

Fig. 5. Statistical analysis comparing endoscopic (*OCuTR*) and open cubital tunnel release (*OCuTR*) rate of reoperation. *M-H*, Mantel-Haenszel.

DISCUSSION

Historically, open cubital tunnel release has been the procedure of choice for most surgeons performing ulnar nerve release at the elbow. Recently, minimally invasive procedures and techniques have become more favorable when applicable. The principle of the endoscopic cubital tunnel release is similar to that of an open cubital tunnel release (i.e., in situ decompression) but uses a smaller incision. The theoretical benefits of endoscopic cubital tunnel release include the reduction in nerve handling, surrounding tissue dissection/trauma, expedited recovery time for patents, reduced vascular complications, and decreased scar discomfort.[15–17]

The use of the endoscopic technique for ulnar nerve decompression at the elbow was first described in 1999.[4] Since then, studies comparing the endoscopic to the open cubital tunnel release have been sparse and hindered by small sample sizes. Therefore, we conducted a systematic review and performed a meta-analysis of five included studies to determine whether a true benefit exists for the use of endoscopic over open cubital tunnel release.

A meta-analysis of 655 patients revealed no statistically significant superiority of open cubital tunnel release over endoscopic cubital tunnel release in Bishop score ratings. Therefore, open cubital tunnel release does not seem to be more efficacious than endoscopic cubital tunnel release in terms of patient subjective postoperative findings. Likewise, open cubital tunnel release did not achieve a statistically significant reduction in visual analogue scale score compared with the endoscopic cubital tunnel release approach, meaning that patients were not more satisfied with the open cubital tunnel release outcomes compared with the endoscopic cubital tunnel release outcomes. Endoscopic cubital tunnel release was found to have a statistically significant lower incidence of scar tenderness/elbow pain, but was noted to have a higher rate of postoperative hematoma formation despite the previously published theoretical benefit of reduced vascular complications. Unfortunately, no further conclusion can be drawn regarding this finding, as the endoscopic technique used was not mentioned. No statistically significant difference was seen between the reoperation rates.

The limitations to this study include those that are inherent in the five included studies. Each individual study included in the meta-analysis had a relatively small sample size, and multiple different surgeons with varying techniques and skill levels operated on these patients. This spectrum bias may limit the universality of these reported findings. Also, four of the five studies were retrospective in nature without randomization of patients or patient matching and have inherent publication bias. Lastly, interrater reliability for study selection was not analyzed statistically.

CONCLUSIONS

We demonstrated equivalent overall clinical improvement between endoscopic and open cubital tunnel release in terms of both Bishop score and visual analogue scale reduction. Endoscopic cubital tunnel release has an added benefit of decreased scar tenderness/elbow pain but had a higher incidence of postoperative hematoma rate. Because of the low power of the included studies, further investigations with a larger patient population, longer follow-up, better documentation of endoscopic devices/techniques used, and criteria for surgical intervention are needed to better characterize the role of endoscopic cubital tunnel release.

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REFERENCES

1. Mondelli M, Giannini F, Ballerini M, Ginanneschi F, Martorelli E. Incidence of ulnar neuropathy at the elbow in the province of Siena (Italy). *J Neurol Sci.* 2005;234:5–10.
2. Boone S, Gelberman RH, Calfee RP. The management of cubital tunnel syndrome. *J Hand Surg Am.* 2015;40:1897–1904; quiz 1904.
3. Soltani AM, Best MJ, Francis CS, Allan BJ, Panthaki ZJ. Trends in the surgical treatment of cubital tunnel syndrome: An analysis of the national survey of ambulatory surgery database. *J Hand Surg Am.* 2013;38:1551–1556.
4. Tsai TM, Chen IC, Majd ME, Lim BH. Cubital tunnel release with endoscopic assistance: Results of a new technique. *J Hand Surg Am.* 1999;24:21–29.
5. Oertel J, Keiner D, Gaab MR. Endoscopic decompression of the ulnar nerve at the elbow. *Neurosurgery* 2010;66:817–824; discussion 824.
6. Saw NL, Jones S, Shepstone L, Meyer M, Chapman PG, Logan AM. Early outcome and cost-effectiveness of endoscopic versus open carpal tunnel release: A randomized prospective trial. *J Hand Surg Br.* 2003;28:444–449.
7. Watts AC, Bain GI. Patient-rated outcome of ulnar nerve decompression: A comparison of endoscopic and open in situ decompression. *J Hand Surg Am.* 2009;34:1492–1498.
8. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. *BMC Med Res Methodol.* 2005;5:13.
9. Schmidt S, Kleist Welch-Guerra W, Matthes M, Baldauf J, Schminke U, Schroeder HW. Endoscopic vs open decompression of the ulnar nerve in cubital tunnel syndrome: A prospective randomized double-blind study. *Neurosurgery* 2015;77:960–970; discussion 970–971.
10. Bacle G, Marteau E, Freslon M, et al. Cubital tunnel syndrome: Comparative results of a multicenter study of 4 surgical techniques with a mean follow-up of 92 months. *Orthop Traumatol Surg Res.* 2014;100(Suppl):S205–S208.
11. Bolster MA, Zöphel OT, van den Heuvel ER, Ruettermann M. Cubital tunnel syndrome: A comparison of an endoscopic technique with a minimal invasive open technique. *J Hand Surg Eur Vol.* 2014;39:621–625.
12. Dützmann S, Martin KD, Sobottka S, et al. Open vs retractor-endoscopic in situ decompression of the ulnar nerve in cubital tunnel syndrome: A retrospective cohort study. *Neurosurgery* 2013;72:605–616; discussion 614–616.
13. McGown AJ. The results of transposition of the ulnar nerve for traumatic ulnar neuritis. *J Bone Joint Surg Br.* 1950;32:293–301.
14. Kleinman WB, Bishop AT. Anterior intramuscular transposition of the ulnar nerve. *J Hand Surg Am.* 1989;14:972–979.
15. Karthik K, Nanda R, Storey S, Stothard J. Severe ulnar nerve entrapment at the elbow: Functional outcome after minimally invasive in situ decompression. *J Hand Surg Eur Vol.* 2012;37:115–122.
16. Konishiike T, Nishida K, Ozawa M, Ozaki T. Anterior transposition of the ulnar nerve with endoscopic assistance. *J Hand Surg Eur Vol.* 2011;36:126–129.
17. Lequint T, Naito K, Awada T, Facca S, Liverneaux P. Ulnar nerve transposition using a mini-invasive approach: Case series of 30 patients. *J Hand Surg Eur Vol.* 2013;38:468–473.