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Original article

Ulnar nerve dislocation in ulnar nerve entrapment at the elbow. Influence on surgical outcome

Luxation du nerf ulnaire lors du syndrome canalaire au coude. Influence sur le résultat chirurgical

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ABSTRACT

Our aim was to assess the incidence of symptomatic ulnar nerve dislocation and its influence on surgical outcome after primary and revision surgeries in ulnar nerve entrapment at the elbow (ulnar neuropathy at the elbow (UNE) or cubital tunnel syndrome). The influence of pre- or intra-operative ulnar nerve dislocation on postoperative outcome was assessed in 548 surgically treated cases (548 nerves) from two hand surgery departments reporting to the Swedish National Quality Registry for Hand Surgery, using QuickDASH, a patient-reported outcome measure (PROM), before surgery and at 3 and 12 months postoperatively, and a doctor-reported outcome measure (DROM), grading as "cured-improved "or "unchanged-worsened," at a median follow-up of 3.0 months [IQR, 1.5–6.0]. 109 of the 548 cases (20%) showed documented pre- or intra-operative ulnar nerve dislocation; more often found at revision (35/75, 47%) than at primary surgery (74/473, 16%) ($p < 0.0001$). Cases with dislocation presented higher QuickDASH scores at 12 months ($p = 0.026$). A linear regression model, adjusted for age and gender, predicted higher QuickDASH scores at 12 months postoperatively for cases with dislocation (unstandardized B 11.3 [95% CI 0.4–22.2], $p = 0.043$). DROM grading as unchanged-worsened at a median 3 months predicted worse QuickDASH scores ($p < 0.0001$) than in cured-improved cases at 3 (unstandardized B, 18.4 [95% CI 9.4–27.3]) and 12 months (unstandardized B, 18.1 [9.1–27.0]). Primary surgeries had better DROM grading than revision surgeries ($p = 0.033$; cured-improved, 75% and 63%, respectively), but QuickDASH scores did not differ. Presence of a clinically relevant ulnar nerve dislocation resulted in worse outcome, perhaps due to more extensive surgery with transposition. Nerve dislocation needs attention when treating UNE patients.

Mots-clés:
Syndrome canalaire au coude
Compression du nerf ulnaire
Simple décompression du nerf
Transposition du nerf ulnaire
Luxation du nerf ulnaire
Score QuickDASH

RÉSUMÉ

Notre but était d'évaluer la présence de la luxation symptomatique du nerf ulnaire et son influence sur le résultat après chirurgie de première intention et reprise chirurgicale du syndrome canalaire au coude. L'influence de la luxation pré- ou per-opératoire du nerf ulnaire sur le résultat post-opératoire a été évaluée dans 548 cas (nerfs) traités chirurgicalement à partir des données fournies par deux départements de chirurgie de la main dans un Registre National de Qualité pour la Chirurgie de la Main, mesurant les résultats rapportés par les patients (PROM, QuickDASH, avant la chirurgie, et à 3 et 12 mois postopératoires) et les résultats rapportés par les médecins (DROM, i.e. évaluation à la dernière visite, guéri–amélioré ou inchangé–aggravé, temps médian de suivi de 3,0 mois [EI 1,5–6,0]). Sur l'ensemble des cas, 109/548 (20%) avaient une luxation pré- ou per-opératoire répertoriée du nerf ulnaire, plus

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fréquemment détectée lors des révisions chirurgicales (35/75, 47%) que lors des chirurgies de première intention (74/473, 16%, p < 0,0001). Parmi les cas avec luxation, on relevait un score QuickDASH plus élevé à 12 mois (p = 0,026). Un modèle de régression linéaire, ajusté pour l'âge et le sexe, prédisait un score QuickDASH plus élevé à 12 mois postopératoire pour les cas avec luxation (B non-standardisé 11,3 [CI 95% 0,4–22,2], p = 0,043). Dans les cas définis comme inchangés–aggravés avec un suivi médian de 3 mois, on pourrait prévoir un plus mauvais score QuickDASH (p < 0,0001) que dans les cas guéris-améliorés à 3 (B non-standardisé 18,4 [95% CI 9,4–27,3]) et 12 mois (B non-standardisé 18,1 [9,1–27,0]). Les chirurgies de première intention obtenaient une meilleur classement DROM que les révisions chirurgicales (p = 0,033, guéris–améliorés, respectivement 75% et 63%) mais les scores QuickDASH n'étaient pas différents. La présence d'une luxation du nerf ulnaire cliniquement significative est associée à un plus mauvais résultat, peut-être causé à la chirurgie plus extensive avec transposition. La luxation du nerf doit être prise en compte quand on traite un syndrome canalaire au coude.

1. Introduction

Ulnar nerve entrapment at the elbow (ulnar nerve neuropathy at the elbow (UNE) or cubital tunnel syndrome) [1,2] is treated surgically using various techniques, with similar outcomes [3,4]. Simple decompression in primary cases is less invasive and surgically easier to perform, with a lower risk of postoperative complications, compared to other techniques [3,5,6]. Transposition surgery is commonly chosen in symptomatic ulnar nerve dislocation (i.e., partial (subluxation) or complete dislocation of the nerve during elbow flexion) as primary attitude or in case of recurrent symptoms requiring revision surgery [7].

Conflicting results have been reported concerning various risk factors for revision surgery [8]. Partial or complete ulnar nerve dislocation is reported in 6–37% of asymptomatic and symptomatic individuals assessed by high-resolution ultrasonography or on clinical evaluation [9–13]. Whether this influences surgical outcome has not been sufficiently studied. However, in a study on submuscular transposition in revision surgery, 76% of cases had preoperative nerve dislocation, and 73% were cured or improved following surgery [7].

Choices in UNE diagnosis and treatment are often strongly dependent on the individual physician and health center [4], which is also true for outcome measures after surgery [14,15]. Various patient-reported outcome measures (PROMs) are used to assess function, health status and satisfaction, all differing in responsiveness and response rate [14,16–18]. It has been reported that a doctor-reported outcome measure (DROM), combining patient-reported and surgeon-evaluated outcome, registered in the patient's records at last follow-up, can supplement PROMs and may correlate with improvement in the QuickDASH PROM (short version of the Disabilities of Arm Shoulder and Hand score) at 1 year postoperatively [19].

The aim of the present study was to assess pre- or intra-operative ulnar nerve dislocation as a factor influencing surgical outcome, using a PROM and a DROM, after primary and revision surgeries for UNE in a large population from two regions in Sweden.

2. Patients and methods

2.1. Patients

All surgically treated UNE cases at the authors' two hand surgery departments, documented in the Swedish Quality Registry for Hand Surgery 2010–2016, were included. UNE cases in the registry were defined as treated ulnar nerves, identified by ICD-10 diagnosis code G562 and surgical codes ACC53 (simple decompression), ACC43 (transposition) or NCK19 (medial epicondylectomy). Both primary and revision surgeries were included.

2.2. Evaluation

In the registry, patients filled in the Swedish version of the QuickDASH questionnaire preoperatively and at 3 and 12 months postoperatively, in web-based or mailed paper form, comprising 11 questions with total score 0–100, higher scores indicating more severe disability [20]. A pre- to post-operative decrease of 7–8 points in total score was considered to reflect a minimal clinically important difference [18]. A postoperative total score of more than 10 was interpreted as persistent symptoms [21,22]. A few patients (n = 15) also completed the full version of the DASH questionnaire, originally as a part of another study published by one of the authors.

All cases in the registry were analyzed retrospectively and additional data (not specified in the registry) were extracted from patient records: primary or revision surgery, pre- or intra-operative ulnar nerve dislocation, concomitant surgical procedures, and DROM grading. Clinically relevant ulnar nerve dislocation was defined as documented pre- or intra-operative nerve subluxation or total dislocation, clinically assessed by the surgeon during active and passive elbow flexion and extension, as noted in the patient records; absence of any documentation in the patient records (n = 173) was presumed to indicate the absence of clinically relevant dislocation, whether partial or complete. Postoperative outcome was assessed, in addition to QuickDASH score, on DROM by one of the authors (IA), a specialist in orthopedic surgery who was not the treating surgeon in any of the cases, who graded treatment response in 4 groups: cured, improved, unchanged or worsened. These were then dichotomized as cured–improved and unchanged–worsened for statistical analyses, as in previous studies [7,23].

2.3. Statistical analyses

Data were presented as medians [interquartile range, Q25–Q75]. Nominal data were presented as numbers (percentages). The chi-square test (Pearson or Fisher's exact test) was used to compare differences in categoric data between groups and the non-parametric Mann–Whitney U-test was used for continuous data. Correlations were assessed on Pearson correlation coefficient for continuous data and on point-biserial correlation coefficient for dichotomous variables (R-value, p-value), as weak (>0.3–0.5), moderate (>0.5–0.7) or strong (>0.7) correlation. Linear regression analyses, adjusted for age and gender, assessed the influence of dislocation and DROM grading on QuickDASH scores at 12 months postoperatively (unstandardized B [95% CI]). P-values <0.05 were considered statistically significant. SPSS Statistics, version 25 (SPSS Inc., Chicago, IL) was used for all calculations. Each treated arm was analyzed as a separate case and statistical entity.

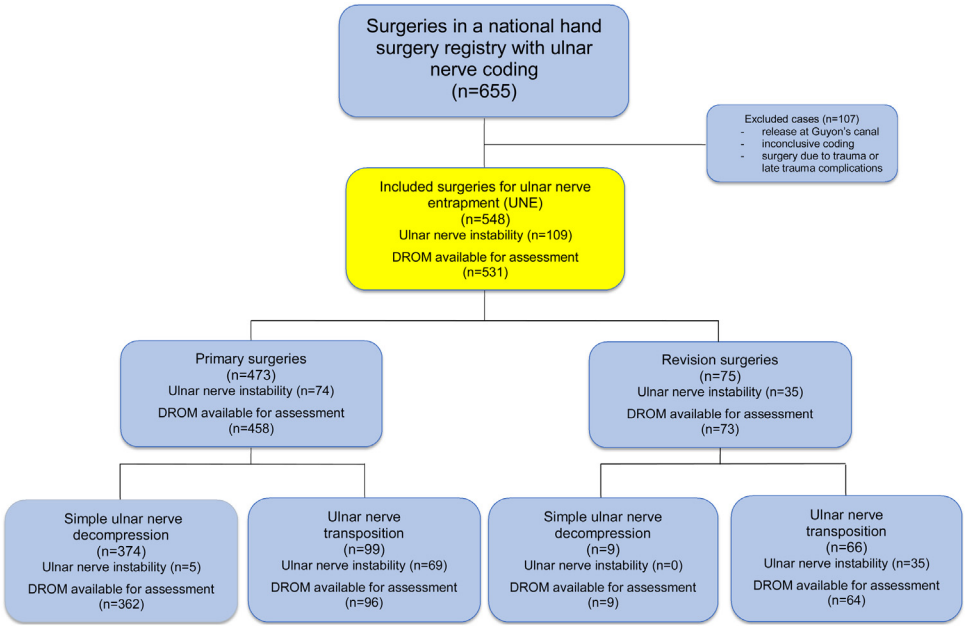

Fig. 1. Flowchart showing the patient cohort with included and excluded cases according to primary and revision surgeries and to surgical procedure.

2.4. Ethical considerations

This research was approved by the IRBs of the authors' affiliated institutions.

3. Results

3.1. Case characteristics

During the study period, 655 surgically treated UNE cases, including 56 bilateral cases in 28 patients, were registered in the national registry (Fig. 1). 107 were excluded: release only at Guyon's canal, acute trauma, late complications of trauma, or inconclusive coding. 473 of the 548 UNE surgeries included were primary and 75 revision surgeries. 374 of the 473 primary surgeries (79%) were simple decompressions and 99 (21%) were ulnar nerve transpositions (i.e., subcutaneous or submuscular transposition, the latter including variants such as intramuscular and subfascial transposition, but nevertheless all defined as submuscular). Nine of the 75 revision surgeries (12%) were simple decompression and 66 (88%) ulnar nerve transposition (Table 1, Fig. 1). No cases were treated by medial epicondylectomy or endoscopic decompression.

In total, 287 of the 548 surgically treated cases (52%) were in females and 261 (48%) in males, with a median age of 50 [IQR 40–59] years and 53 [IQR 44–61] years, respectively (Table 1). 109 of the 548 cases (20%) had clinically relevant and documented pre- or intra-operative ulnar nerve dislocation. QuickDASH response rates were 129/548 (24%) preoperatively, 143/519 (28%) at 3 months and 129/453 (28%) at 12 months; numbers at the postoperative time points were lower due to cases operated on in 2016 and thus not able to respond at 3 and 12 months. Fifteen of the 129 cases with registered QuickDASH scores at 12 months (12%) also had registered full-scale DASH scores, sent out to the patients after the last outpatient consultation and originally published in an article by one of the present authors [5]. DROM grading was performed in 531/548 cases (97%), with no postoperative outcome noted in the patient records for the other 17 cases (3%). Characteristics according to surgical procedure are presented in Table 1.

Concomitant surgery was performed for other nerve entrapments in 63 of the 548 cases (11%): 48 (76%) for carpal tunnel

Table 1
Characteristics of 548 surgically treated cases with ulnar nerve entrapment at the elbow (UNE) according to surgical procedure.

	Primary simple ulnar nerve decompression (n = 374)	Primary ulnar nerve transposition (n = 99)	Revision simple ulnar nerve decompression (n = 9)	Revision ulnar nerve transposition (n = 66)
Characteristics				
Age, years	53 [44–61]	47 [34–59]	40 [34–53]	50 [40–56]
Male/female	182 (49%)/192 (51%)	51 (52%)/48 (48%)	4 (44%)/5 (66%)	24 (36%)/42 (64%)
Concomitant surgical nerve procedure(s)	45 (12%)	8 (8%)	1 (11%)	9 (14%)
Concomitant hand Surgery procedures(s)	24 (6%)	9 (9%)	0 (0%)	1 (2%)
Documented ulnar nerve dislocation [a]	5 (1%)	69 (70%)	0 (0%)	35 (53%)
DROM [b]				
Cured-Improved	269 (72%)	75 (76%)	5 (56%)	41 (62%)
Unchanged-Worsened	93 (25%)	21 (21%)	4 (44%)	23 (35%)
Missing data	12 (3%)	3 (3%)	0 (0%)	2 (3%)
QuickDASH score				
Preoperative	52 [34–66] (n = 91)	57 [42–73] (n = 26)	NA	63 [29–72] (n = 12)
3 months postoperative	32 [14–58] (n = 106)	49 [35–59] (n = 16)	NA	39 [18–59] (n = 19)
12 months postoperative	39 [16–59] (n = 99)	50 [42–66] (n = 16)	NA	42 [33–63] (n = 12)

Table 2
Outcome in 548 surgically treated cases of ulnar nerve entrapment at the elbow (treated with simple decompression or ulnar nerve transposition), with or without clinically relevant and documented pre- or intra-operative ulnar nerve dislocation assessed on Doctor-Reported Outcome Measure (DROM) and QuickDASH score.

	Ulnar nerve dislocation n = 109	No ulnar nerve dislocation n = 439	P-value
DROM			
Cured-improved	79 (75)	311 (73)	0.71
Worsened-unchanged	26 (25)	115 (27)	
QuickDASH			
Preoperatively	57 [36–66] (n = 27)	55 [39–68] (n = 102)	0.78
3 months postoperatively	47 [19–61] (n = 24)	32 [14–57] (n = 119)	0.20
12 months postoperatively	50 [36–64] (n = 23)	39 [16–59] (n = 106)	**0.026**

Data are presented as n (%) and medians [interquartile range; Q25–Q75]. Statistical differences were analyzed on Chi-square test and Mann–Whitney U test. Information in patient records regarding clinically relevant ulnar nerve dislocation was missing in 173 cases, presumed to signify no clinically relevant dislocation. Median follow-up for the DROM at last clinical follow-up was 3.0 months [IQR 1.5–6.0]. DROM grading data were missing in 17 cases. Bold indicates significant difference.

syndrome, 7 (11%) for ulnar nerve decompression at Guyon's canal, 4 (6%) for both, and 4 (6%) for radial nerve decompression. In 34 of the 548 cases (6%), other concomitant hand surgery procedures were performed: 10 (29%) for trigger finger, 5 (15%) for first carpometacarpal osteoarthritis, of the thumb, 2 (6%) for ganglion, 2 (6%) for Quervain's tenosynovitis, 2 (6%) for synovectomy, 1 (3%) for Dupuytren's contracture and 12 (35%) other or multiple procedures. Diabetes was present as a comorbidity in 65 of the 548 cases (12%) (missing data in 6/548: 1%).

3.2. Ulnar nerve dislocation and evaluation on DROM and QuickDASH

One hundred and nine of the 548 cases (20%) showed documented clinically relevant pre- or intra-operative ulnar nerve dislocation according to the surgeon and noted in the patient record; if there was no documentation in the record (n = 173), this was presumed to mean no clinically relevant dislocation. Significantly more cases with documented ulnar nerve dislocation were found in revision surgeries (n = 35/75, 47%) than primary surgeries (n = 74/473, 16%; $p < 0.0001$) (Table 2). In primary surgeries, almost all cases with documented ulnar nerve dislocation underwent nerve transposition (n = 69/74, 93%, $p < 0.0001$), which is the usual attitude in Sweden, and in revision surgeries all documented dislocations underwent transposition (n = 35/35, 100%; p = 0.003), in contrast to cases where no dislocation was documented (n = 30/399, 8% and n = 31/40, 78%, respectively).

Cases with documented clinically relevant pre- or intra-operative ulnar nerve dislocation, including both primary and revision surgeries, showed higher QuickDASH scores at 12 months (p = 0.026) than cases with no nerve dislocation (Table 2). No such difference was seen preoperatively or at 3 months postoperatively (p = 0.78 and p = 0.20, respectively). Presence of documented clinically relevant ulnar nerve dislocation predicted higher QuickDASH scores at 12 months postoperatively (11.3 [95% CI, 0.4–22.2], p = 0.043). Median follow-up for DROM grading (at last clinical follow-up) was 3.0 months [IQR 1.5–6.0], with no difference in surgical outcome (p = 0.71, Table 2).

3.3. All surgically treated cases and evaluation on QuickDASH and DROM

Preoperative QuickDASH scores did not differ between the two DROM groups (cured–improved or unchanged–worsened, p = 0.24; Table 3). At both 3 ($p < 0.0001$) and 12 months ($p < 0.0001$), cases graded as cured–improved had a significantly lower QuickDASH score than cases graded as unchanged–worsened (Table 3).

A strong positive correlation (r = 0.70, p = 0.004) was found between postoperative DASH score (minimum follow-up, 12 months; obtained in n = 15 and compared with QuickDASH score in the same patients; see Methods) and QuickDASH scores at 12 months postoperatively. A weak positive correlation was found between DROM grading and QuickDASH score at 3 (r = 0.33, $p < 0.0001$) and 12 months (r = 0.34, $p < 0.0001$). DROM grading of unchanged–worsened predicted higher postoperative QuickDASH scores at both 3 (unstandardized B 18.4 [95% CI, 9.4–27.3]; $p < 0.0001$) and 12 months (unstandardized B 18.1 [95% CI, 9.1–27.0]; $p < 0.0001$) in the linear regression analysis (adjusted for age and gender). Follow-up for patients considered cured–improved was shorter (2.0 [1.5–5.0] months) than for patients considered unchanged–worsened (6.0 [2.0–10.0] months, p = 0.0001).

3.4. Primary and revision surgery and evaluation by DROM and QuickDASH

On DROM grading, primary surgeries showed better outcome than revision surgeries (p = 0.03). Revision surgery did not differ from primary surgery on pre- or post-operative QuickDASH score (Table 4).

3.5. Primary simple decompression and ulnar nerve transposition surgery and evaluation by DROM and QuickDASH

Primary simple decompression and primary ulnar nerve transposition did not statistically differ on DROM grading

Table 3
Relation between outcome assessed on QuickDASH preoperatively and at 3 and 12 months postoperatively and Doctor-Reported Outcome Measure (DROM) grading at last clinical follow-up (median 3 months) in 531 surgically treated cases with ulnar nerve entrapment at the elbow.

QuickDASH score	DROM Cured-improved (n = 390)	DROM Unchanged-worsened (n = 141)	P-value
Preoperatively	55 [32–66] (n = 91)	57 [43–68] (n = 37)	0.24
3 months postoperatively	27 [14–48] (n = 100)	51 [32–69] (n = 38)	<**0.0001**
12 months postoperatively	36 [16–55] (n = 91)	60 [41–70] (n = 34)	<**0.0001**

Data are presented as medians [interquartile range; Q25–Q75]. Statistical differences were analyzed on Mann–Whitney U test. Median follow-up for DROM grading (at last clinical follow-up) was 3.0 months [IQR 1.5–6.0]. Bold indicates significant difference.

Table 4
Outcome in 548 cases of ulnar nerve entrapment at the elbow treated with primary or revision surgery assessed using Doctor-Reported Outcome Measure (DROM) and QuickDASH, preoperatively and at 3 and 12 months postoperatively.

	Primary surgery (n = 473)	Revision surgery (n = 75)	P-value
DROM			
Cured-improved	344 (75)	46 (63)	**0.03**
Worsened-unchanged	114 (25)	27 (37)	
QuickDASH			
Preoperatively	55 [39–67] (n = 117)	63 [29–72] (n = 12)	0.51
3 months postoperatively	32 [14–58] (n = 122)	39 [18–60] (n = 21)	0.29
12 months postoperatively	41 [18–61] (n = 115)	42 [29–62] (n = 14)	0.76

Data are presented as n (%) and medians [interquartile range; Q25–Q75]. Statistical differences were analyzed on Chi-square test and Mann–Whitney U test. Median follow-up for the DROM at last clinical follow-up was 3.0 months [IQR 1.5–6.0]. DROM data were missing in 17 cases. Bold indicates significant difference.

Table 5
Outcome in 473 cases of ulnar nerve entrapment at the elbow treated with primary simple decompression and primary ulnar nerve transposition surgery, assessed on QuickDASH preoperatively and at 3 and 12 months postoperatively.

	Primary simple ulnar nerve decompression (n = 374)	Primary ulnar nerve transposition (n = 99)	P-value
DROM			
Cured-improved	269 (74)	75 (78)	0.51
Worsened-unchanged	93 (26)	21 (22)	
QuickDASH			
Preoperatively	52 [34–66] (n = 91)	57 [42–73] (n = 26)	0.40
3 months postoperatively	32 [14–58] (n = 106)	49 [35–59] (n = 16)	0.11
12 months postoperatively	39 [16–59] (n = 99)	50 [42–66] (n = 16)	**0.049**

Data are presented as n (%) and medians [interquartile range; Q25–Q75]. Statistical differences were analyzed on Chi-square test and Mann–Whitney U test. Median follow-up for the DROM (doctor-related outcome measure) at last clinical follow-up was 3.0 months [IQR 1.5–6.0]. DROM grading data were missing in 15 cases. Bold indicates significant difference.

(p = 0.51) or on preoperative or 3-month QuickDASH, but primary simple decompression cases showed better outcome on QuickDASH at 12 months (p = 0.049, Table 5).

4. Discussion

The present study indicates that clinically relevant pre- or intra-operative ulnar nerve dislocation is common in surgically treated patients with UNE. These dislocations did not seem to influence outcome at 3 months postoperatively as assessed by DROM or PROM (QuickDASH), but 12-month outcome was poorer in case of ulnar nerve transposition. Patients with a poorer DROM grade at 3 months had higher QuickDASH scores at 3 and 12 months postoperatively. Surgical outcome was better after primary than revision surgery on DROM at 3 months, but not on QuickDASH at either 3 or 12 months. There was no difference between primary simple ulnar nerve decompression and primary transposition on DROM or QuickDASH at 3 months, but outcome was slightly worse at 12 months on QuickDASH after transposition.

In primary UNE, simple decompression is usually the gold-standard surgical treatment. If ulnar nerve dislocation is found pre- or intra-operatively during primary simple decompression, transposition is generally performed as primary procedure according to present Swedish clinical traditions. In revision surgery, transposition would most probably be chosen, regardless of nerve stability status [4]. In the present study, we found clinically relevant pre- or intra-operative ulnar nerve dislocation in 74 of the 473 primary UNE cases (16%) and a total of 109 out of all 548 surgeries (including revisions) (20%), in agreement with a previous larger study of symptomatic UNE patients, reporting 21% partial and complete dislocations [13]. Another study, similar in size to the present one, reported a 46% rate of ulnar nerve dislocation (including partial dislocation) in patients with UNE detected and defined on ultrasound [12]: i.e., more than twice the present rate, but not related to later choice of treatment. Larger studies reported that 32–46% of the general population have an unstable ulnar nerve (defined as both partial and complete dislocation), although these findings do not match UNE symptomatology [9–11].

The higher frequency of clinically relevant ulnar nerve dislocation in the cases of primary transposition probably reflects the above-mentioned operative treatment choices. Primary simple ulnar nerve decompression and transposition cases showed equivalent preoperative symptoms on QuickDASH score. However, at 12 months postoperatively, simple decompression showed better outcome, possibly due to a high rate of clinically relevant ulnar nerve dislocation that required ulnar nerve transposition. Cases with ulnar nerve dislocation had worse outcome on QuickDASH 12 months postoperatively. A recent Swedish national quality registry study reported that ulnar nerve transposition in UNE patients showed poorer outcome than simple decompression on QuickDASH at 12 months [20].

We analyzed the relation between a simple DROM, evaluated by a non-treating surgeon based on documented information in the patient records at last follow-up [7], and the widely used PROM, QuickDASH [17,24]. The diagnosis-specific PROM for UNE, the Patient-Rated Ulnar Nerve Evaluation (PRUNE) [16], was not available in Swedish at the time of the study. Cases graded cured–improved on DROM reported significantly lower QuickDASH scores. Additionally, there was a significant, although weak, correlation between DROM and postoperative QuickDASH score, indicating that a simple DROM correlates with postoperative QuickDASH, as previously reported [19]. Further, a strongly significant correlation was found between postoperative DASH and QuickDASH scores. Taken together, these results support for a relationship between DROM, usually graded at a single time point, and PROMs, such as QuickDASH, which can be assessed repeatedly. DROM may be used independently or as a complement to PROMs in clinical practice.

We found no difference in preoperative QuickDASH score between primary and revision surgeries, despite our population having a higher median preoperative QuickDASH score of 52–63 than the mean 38 points previously reported for DASH in UNE cases [24]. Interestingly, we found similar QuickDASH scores in primary and revision surgeries at both 3 and 12 months, meaning that patients perceived their disability as equally pronounced. Although primary surgeries had better outcome than revision surgeries on DROM, only 75% of primary surgeries were judged cured–improved, in agreement with our previous study [7]. This might reflect the high postoperative QuickDASH scores, due to residual symptoms and disabilities after primary surgery [20]. In assessing pre- or post-operative symptoms and disability on QuickDASH, the patient has to grade all difficulties, whether on the treated side or not, whereas DROM grading considers only the surgically treated side, which may cause some discrepancies in the grading of outcome. Theoretically, the need for treatment of other concomitant hand surgery conditions or bilateral surgery may influence preoperative symptoms and postoperative outcome, but most probably influenced the present data only marginally, as indicated above for primary and revision surgeries and as shown for surgery for carpal tunnel syndrome [25].

Data for the preoperative electrophysiological examinations were not included, since this was not within the scope of the study, but preoperative conduction block or signs of axonal degeneration predict poorer outcome of surgery [23]. In previous reports, ulnar nerve dislocation was not associated with clinical and electrodiagnostic characteristics [13]. Interestingly, ulnar nerve dislocation is frequent in healthy subjects [10,11,13], not necessarily inducing UNE [26].

The fact that recurrent UNE is mainly treated by transposition surgery is also reflected in our results. Analyzing revision surgeries on DROM showed that 63% of cases were judged cured–improved postoperatively, which is a lower rate than published elsewhere (73–86%) [13,27,28]. Together with the finding that cases with clinically relevant ulnar nerve dislocation had significantly worse outcome on QuickDASH at 12 months, this leads us to speculate once again whether our findings concerning outcome should be interpreted in terms of ulnar nerve dislocation or of risk of complications after transposition [3,5,6] in revision surgeries due to recurrent UNE. Transposition involves extensive surgery, with risk, for example, of jeopardizing the intraneural microcirculation of the nerve during dissection, causing complications [3,5,6].

The most obvious limitation of the present study, related to its retrospective design, was the low response rate for PROM scores (QuickDASH), which, while in agreement with similar previous studies, could never be as high as in a prospective cohort study. There are few prospective studies with proper randomization according to preoperative symptom grading. The low PROM response rate may partly explain some of the discrepancies in outcome assessment on DROM and QuickDASH. The national registry is also fairly new, with foreseeable start-up problems.

It is a strength of the present study that we used validated internationally accepted PROMs (QuickDASH and DASH) for assessing treatment outcome, with comparison to a simple DROM, although the more diagnosis-specific PRUNE instrument could be used in the future, once it has been translated and validated in the appropriate language, which is presently being done for Swedish [16,29]. Both DASH and its currently used short QuickDASH version, as well as a reliable specific hand surgery questionnaire (HQ-8, [20]), are well known and validated for evaluating upper-limb disability and correlate well in a normal population [30].

5. Conclusion

Clinically relevant ulnar nerve dislocation in UNE may result in poorer surgical outcome, probably associated with transposition surgery, and needs to be taken into account when treating UNE patients.

Ethics

The study was approved by the Regional Ethical Review Boards in Lund (N° 2016/931 and 2018/57) and Linköping (N° 2016/88-31), Sweden.

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Disclosure of interest

The authors declare that they have no competing interests.

CRediT authorship contribution statement

I. Anker: Conceptualization, Resources, Data curation, Software, Investigation, Visualization, Methodology, Writing – original draft, Project administration, Writing – review & editing. **M. Zimmerman:** Conceptualization, Resources, Formal analysis, Supervision, Investigation, Visualization, Project administration, Writing – review & editing. **E. Nyman:** Conceptualization, Resources, Formal analysis, Supervision, Investigation, Visualization, Project administration, Writing – review & editing. **L.B. Dahlin:** Conceptualization, Resources, Data curation, Software, Formal analysis, Supervision, Funding acquisition, Validation, Investigation, Visualization, Project administration, Writing – review & editing.

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