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Hand therapy referral for hand fractures and dislocations: A multicenter snapshot study

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ABSTRACT

Background: It is unclear which patients with fractures and dislocations of the hand necessitate hand therapy referral, which can lead to practice variation.
Purpose: The study aimed to evaluate hand therapy referral patterns following non-operative and operative treatments of hand fractures and dislocations and to identify practice variations.
Study Design: This multicenter, observational snapshot study was conducted across 12 hospitals in the Netherlands over a 3-month period in 2020.
Methods: Adult patients admitted to the emergency department with metacarpal and phalangeal fractures or dislocations were included. Analyses were stratified by hand therapy referral status for different injury categories following non-operative and operative treatment. Determinants for hand therapy referral, including patient and injury characteristics, hospital setting, and medical specialty, were assessed using multivariable logistic regression.
Results: Of 1654 included patients, 22% (306/1405) were referred to hand therapy after non-operative treatment, and 72% (178/249) after operative treatment. Among the 10 most prevalent injuries treated non-operatively, referral rates were highest for dislocations of digits two to five (43% [48/112]), followed by middle phalanx shaft fractures (34% [11/32]), and mallet fractures (33% [23/70]). The referral rates across hospitals significantly differed for metacarpal shaft fractures, dislocations of digits two to five, and proximal interphalangeal joint palmar plate avulsion fractures. Among the five most prevalent injuries treated operatively, middle and proximal phalanx shaft fractures were most frequently referred (90% [9/10] and 87% [33/38]), and referral rates across hospitals varied between 28% (95% confidence interval: 13%-50%) and 89% (95% confidence interval: 51%-100%). In multivariable logistic regression, hospital setting and medical specialty were determinants of hand therapy referral ($p < 0.001$ and $p < 0.001$).
Conclusions: There is considerable practice variation in hand therapy referral within injury categories, which seems to be largely attributed to hospital setting and medical specialty. This highlights the knowledge gap in this field.

Introduction

Hand fractures and dislocations are common injuries that can result in significant functional impairment and disability. Studies have reported that hand fractures comprise 10%-19% of all fracture presentations, with the majority of these injuries occurring in the young and middle age groups.[1-3] Treatment of hand fractures and dislocations is complex due to the potential development of stiffness of the wrist and finger joints.[4-6] Hand therapy is a specialized form of rehabilitation that aims to improve the function of the hand and upper extremity and can be used as an adjunct to both non-operative

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and operative management. However, the specific criteria for referring patients to hand therapy are not well-defined for the majority of hand fractures.

In 2018, the Dutch Society for Plastic Surgery and the Dutch Society for Surgery developed a guideline for the treatment of hand fractures and dislocations.[7] The guideline suggests that hand therapy referral should be considered for all patients with non-operatively managed intra-articular fractures and dislocations. For surgically treated mid- and proximal phalanx fractures, it is advised to start postoperative hand therapy within 5 days to prevent secondary stiffness. In cases of metacarpal (MC) shaft fractures, hand therapy is recommended if there is no progressive improvement in active movement within 1-2 weeks. Hand therapy should also be started in cases involving more severe injuries, such as multiple fractures, crush injuries, or excessive edema, to prevent complications. These recommendations are based on a limited number of low-quality evidence studies or expert experience.[8] The evidence is insufficient to provide a comprehensive overview of specific hand fractures and dislocations that require hand therapy and the current referral rate to hand therapy is unknown.[9-11]

Therefore, the aim of this multicenter snapshot study was to evaluate patterns in hand therapy referral for patients with hand fractures and dislocations and to identify practice variations. The secondary aim was to assess the association between hand therapy referral and patient-reported hand function 3 months following injury.

Materials and methods

Study design

A multicenter, observational, cross-sectional, snapshot study was conducted in 12 hospitals in the Netherlands (one academic teaching hospital, one community nonteaching hospital, and 10 community teaching hospitals). The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology statement.[12] The Medical research Ethics Committees United and institutional review boards of all participating hospitals approved the study. A waiver of informed consent was granted due to the study design and the expected large sample size where obtaining consent from the expected 2500 patients would require disproportionate effort and could result in significant selection bias. Data were stored using Castor Electronic Data Capture software.

Patient selection

All patients presenting to the emergency department (ED), from August to October 2020, with MC and phalangeal fractures or dislocations of the proximal interphalangeal joint (PIPJ), distal interphalangeal joint, interphalangeal joint of the thumb, and metacarpophalangeal joint, were eligible for inclusion. Throughout the inclusion period, there were no restrictions imposed due to the COVID-19 pandemic, which may have led to a lower incidence of fractures. Patients were identified using the daily admission list of the ED and the daily radiology list. Exclusion criteria were dislocations that were not confirmed by clinical examination of a physician or radiograph (ie, dislocations that had spontaneously reduced or had been reduced by the patient or a non-medical person), carpometacarpal dislocations, pathologic fractures, and amputations. Also, records lacking details on injury classification or hand therapy referral and patients who did not visit the ED within 14 days after the injury were excluded.

Patients who had their email addresses recorded in the electronic patient file received a web-based Michigan Hand Outcomes Questionnaire (MHQ) 3 months following injury, as part of standard clinical care. Non–Dutch-speaking patients, as well as patients with neurodevelopmental disorders and cognitive disorders, were excluded from receiving the questionnaire. To comply with local ethical requirements for this study, an additional question was included in the MHQ to obtain explicit consent for using their data for research purposes. Only patients who provided consent were included in the analysis, while those who declined were excluded.

Study variables and outcomes

The following patient characteristics were recorded: sex, age, working status (student, working, not working, retired, unknown), hand comorbidities (inflammatory arthritis, osteoarthritis, Dupuytren's contracture, carpal tunnel syndrome, trigger finger, ganglion/cyst, previous trauma, previous burn injury, hand tumor, paralysis, degenerative muscle disease, or other hand comorbidity of the affected hand), smoking, diabetes, days between injury and presentation, mechanism of injury (low energy, high energy, or crush injury), treatment strategy (operative or non-operative treatment), soft tissue damage (including open fractures, significant lacerations, ligament, tendon, and nail bed injuries), clinically observed angulation, clinically observed rotational deformity, fracture displacement of more than 2 mm on the radiograph, number of fractures and/or dislocations, medical specialty (trauma surgery, plastic surgery, orthopedic surgery, emergency physician), hospital setting, and hand therapy referral. The diagnosis was made by the emergency physician at the time of the patient's presentation to the ED and was documented in the patient record, indicating that a closed reduction had been applied. If a closed reduction was documented or if a dislocation was confirmed by radiograph, the injury was classified as a dislocation. Radiographic confirmation was not always required, as dislocations are often repositioned before a radiograph can be obtained. Fractures were diagnosed by plain radiography. Fracture classification was based on the Orthopedic Trauma Association and the AO Foundation 2018 classification compendium (AO/OTA 2018) and the Dutch guideline for hand fractures 2018. Uncertainties in fracture classification or treatment methods were clarified through consultation with a trauma surgeon. In terms of medical specialty, if patients were solely assessed by an emergency physician in the ED, medical specialty was categorized as emergency physician. For patients requiring follow-up, the specific specialist, whether a trauma surgeon, plastic surgeon, or orthopedic surgeon, was determined by the hospital's logistical arrangements.

The primary outcome was hand therapy referral, defined as referral to hand therapy by the treating physician, as documented in the patient file. If the patient was referred to hand therapy after the last follow-up appointment of the regular treatment, this was not included in the database, since this was beyond the data inclusion period. Patients who were only assessed by an emergency physician at the ED, and who were referred to hand therapy for further follow-up, were referred according to local hospital protocols.

The secondary outcome was the MHQ score, used to assess hand function.[13,14] The MHQ consists of 37 items that are grouped into six domains: overall hand function, participation in daily activities, perceived pain, patient satisfaction, work performance, and esthetics of the hand. Individual domain scores are added up and converted to a total score ranging from 0 to 100, where 0 indicates severe disability and 100 indicates no disability.[15] MHQ scores of patients referred to hand therapy were compared to scores of patients who were not referred to hand therapy.

Statistical methods

Categorical variables were summarized using frequencies and percentages. Continuous variables were presented as mean and

standard deviation, or as median and interquartile ranges depending on the (visual) distribution of the data. To explore between-group differences in referral status, the unpaired two sample t-test or Mann-Whitney U test was used for continuous variables, as appropriate; for categorical variables, the Fisher exact test and chi-square test were used.

To assess the degree of variation in the proportion of patients referred to hand therapy across hospitals, we performed a chi-square test or Fisher exact test as appropriate. This analysis was conducted separately for the five most common injury categories treated non-operatively, as a substantial number of injuries per hospital is needed. Another analysis was performed for all operatively treated injuries combined, as we assume that injury type does not influence the outcomes of this analysis since hand therapy referral is recommended for injuries treated operatively.

Two multivariable logistic regression analyses were performed to identify factors influencing hand therapy referral in patients with one of the 10 most common injury types (n = 1144). The first analysis assessed the impact of hospital setting on hand therapy referral, while the second analysis focused on the variation caused by medical specialty. Expert-based variable selection was used to select independent variables for the analysis including sex, age, trauma mechanism, hand comorbidity, soft tissue damage, clinically observed angulation, clinically observed rotational deformity, and displacement on the radiograph (> 2 mm), treatment method, and injury category. In total, 5% (53/1144) of the cases had missing data, with 12 cases missing data on soft tissue damage, 14 on clinically observed angulation, and 36 on clinically observed rotational deformity. Missing values were imputed by assuming the absence of the outcome.

MHQ scores were analyzed for total MHQ scores and per domain. Analyses were stratified by hand therapy referral status following non-operative and operative treatment. Wilcoxon rank-sum test was used to calculate p-values. Multivariable linear regression analysis was performed to study the association between hand therapy referral and MHQ score for patients with one of the 10 most common injury types, and was corrected for patient and injury characteristics (sex, age, trauma mechanism, hand comorbidity, soft tissue damage, clinically observed angulation, clinically observed rotational deformity, and displacement on the radiograph [> 2 mm], treatment method, and injury category).

All statistical tests were two-sided and statistical significance was set at $p < 0.05$. All statistical analyses were performed using R studio version 2023.06.0+421. Tables were summarized using the gtsummary package, developed for reporting medical research.[16]

Results

Patient and injury characteristics

During the 3-month inclusion period, a total of 2543 patients were registered in the data set; 1718 adults and 825 children (age 0 -17). After excluding children, patients who presented more than 14 days after the date of injury, and records lacking data on injury classification or hand therapy referral details, 1654 patients were included for analysis. After excluding patients with neurodevelopmental and cognitive disorders and non–Dutch-speaking patients, 1587 patients were eligible to fill in the MHQ. Finally, 1171 patients whose mail addresses were registered in the hospital system received the MHQ and 496 (30%) patients completed the MHQ. In Supplementary Table 1, differences in baseline characteristics between patients who completed the MHQ and non-eligible patients and non-responders are presented. Of the patients who completed the MHQ, a greater proportion were referred for hand therapy (38%) compared to those who were not referred (25%), $p < 0.001$. Additionally, a smaller proportion of MHQ respondents were male (57%) compared to non-eligible and non-responding patients (66%), $p < 0.001$. Respondents were also older, with a median age of 49 years (Interquartile range (IQR) 31-63) compared to 38 years (IQR 26-56) for non-responders, $p < 0.001$, a higher percentage of respondents were working (54% vs 46%, $p = 0.001$), and more respondents had undergone surgery (21%) compared to non-responders (12%), $p < 0.001$. Soft tissue injury was slightly more common among respondents (22% vs 17%, $p = 0.040$).

Of 1654 patients, 85% (n = 1405) were treated non-operatively and 15% (n = 249) operatively. Of patients treated non-operatively, 22% (306/1405) were referred to hand therapy, and of patients treated surgically 72% (178/249). In bivariable analysis among patients treated non-operatively, comparing patients who were not referred to hand therapy to patients who were referred to hand therapy, significant differences in sex, age, work status, trauma mechanism, number of fractures or dislocations, clinically observed angulation, and medical specialty were observed. Among operatively treated patients, we observed significant differences in the number of fractures and dislocations, clinically observed angulation, and medical specialty (Table 1).

Patterns in hand therapy referral and practice variation

Among non-operatively treated patients, referral rates for the most common injury categories were as follows: 43% (48/112) for patients with dislocations of digits two to five, 34% for middle phalanx (P2) shaft fractures of digits two to five, 33% (23/70) for mallet fractures, 26% (38/138) for PIPJ palmar plate avulsion fractures, and 20% (22/108) for proximal phalanx (P1) shaft fractures. Figure 1 shows the results for the 10 most common injury categories treated non-operatively. In Supplementary Figure 1, the results for all injury categories are provided.

Among the five most common injuries treated operatively, P2 shaft fractures and P1 shaft fractures were most frequently referred (90% [9/10] and 87% [33/38]) (Fig. 2). The results for all operatively treated injuries are provided in Supplementary Figure 2.

Regarding MC shaft fractures, the referral rates across hospitals significantly differed, and ranged between 0% (95% confidence interval [CI]: 0%-24%) and 42% (95% CI: 21%-66%) ($p = 0.010$). This difference was also observed for dislocations of digits two to five, with referral rates between 0% (95%CI: 0%-24%) and 100% (95% CI: 46%-100%), ($p = 0.005$), PIPJ palmar plate avulsion fractures, 12% (95% CI: 10%-53%) and 100% (95% CI: 60%-100%) ($p = 0.003$), and injuries treated operatively, 28% (95% CI: 13%-50%) to 89% (95% CI: 51%-99%) ($p < 0.001$). Details on referral rates between hospitals for the five most common injury categories treated non-operatively and for operatively treated injuries are provided in Figure 3.

The multivariable logistic regression analyses to identify factors influencing hand therapy referral indicated that hospital setting and medical specialty were both determinants of hand therapy referral ($p < 0.001$ and $p < 0.001$) (Tables 2 and 3). Additionally, being female, operative treatment, and type of injury were associated with hand therapy referral in both analyses. For the analysis of the influence of hospital setting on hand therapy referral, the presence of fracture displacement of more than 2 mm on the radiograph was also associated with hand therapy referral.

Patient-reported hand function

Of patients treated non-operatively, patients who were referred to hand therapy had a lower MHQ score compared to patients who were not referred to hand therapy (74 [IQR: 59-87] vs 82 [IQR: 69-92] vs, $p < 0.001$). After operative treatment the MHQ score of patients who were referred to hand therapy was 76 (IQR: 65, 84) and of

Table 1
Patient and injury characteristics of patients with hand fractures and dislocations stratified by hand therapy referral status following non-operative and operative treatment

	Non-operative treatment				Surgery			
	Overall N = 1405	No hand therapy N = 1099	Hand therapy N = 306	*p*-value*	Overall N = 249	No hand therapy N = 71	Hand therapy N = 178	*p*-value*
Male sex	875 (62%)	716 (65%)	159 (52%)	**< 0.001**	174 (70%)	56 (79%)	118 (66%)	0.051
Median age in years (IQR)	41 (27, 60)	39 (27, 60)	48 (31, 61)	**0.005**	38 (26, 54)	35 (22, 52)	38 (28, 54)	0.3
Work status				**0.003**				0.2
Student	118 (8.4%)	104 (9.5%)	14 (4.6%)		18 (7.2%)	9 (13%)	9 (5.1%)	
Working	657 (47%)	491 (45%)	166 (54%)		150 (60%)	40 (56%)	110 (62%)	
Not working	91 (6.5%)	66 (6.0%)	25 (8.2%)		26 (10%)	5 (7.0%)	21 (12%)	
Retired	182 (13%)	146 (13%)	36 (12%)		18 (7.2%)	4 (5.6%)	14 (7.9%)	
Unknown	357 (25%)	292 (27%)	65 (21%)		37 (15%)	13 (18%)	24 (13%)	
Smoking	189 (25%)	151 (27%)	38 (21%)	0.2	53 (30%)	17 (35%)	36 (28%)	0.4
Unknown	659	531	128		73	22	51	
Diabetes	57 (4.3%)	45 (4.4%)	12 (4.1%)	0.8	8 (3.3%)	4 (6.2%)	4 (2.3%)	0.2
Unknown	86	75	11		8	6	2	
Hand comorbidity	180 (13%)	141 (13%)	39 (13%)	> 0.9	16 (6.4%)	3 (4.2%)	13 (7.3%)	0.6
Trauma mechanism				**< 0.001**				0.3
Low energy	1208 (86%)	928 (84%)	280 (92%)		210 (84%)	64 (90%)	146 (82%)	
High energy	14 (1.0%)	9 (0.8%)	5 (1.6%)		9 (3.6%)	1 (1.4%)	8 (4.5%)	
Crush	183 (13%)	162 (15%)	21 (6.9%)		30 (12%)	6 (8.5%)	24 (13%)	
Median days from injury to presentation (IQR)	0 (0, 1)	0 (0, 1)	0 (0, 1)	0.11	0 (0, 1)	0 (0, 1)	0 (0, 1)	0.2
Number of fractures/dislocations				**0.030**				**0.014**
Multiple	118 (8.4%)	83 (7.6%)	35 (11%)		40 (16%)	5 (7.0%)	35 (20%)	
One	1287 (92%)	1016 (92%)	271 (89%)		209 (84%)	66 (93%)	143 (80%)	
Soft tissue damage	253 (18%)	199 (18%)	54 (18%)	0.5	52 (21%)	16 (23%)	36 (20%)	0.7
Unknown	11 (0.8%)	7 (0.6%)	4 (1.3%)		3 (1.2%)	0 (0%)	3 (1.7%)	
Clinically observed angulation	140 (10.0%)	96 (8.7%)	44 (14%)	**0.010**	91 (37%)	24 (34%)	67 (38%)	**0.019**
Unknown	10 (0.7%)	9 (0.8%)	1 (0.3%)		8 (3.2%)	6 (8.5%)	2 (1.1%)	
Clinically observed rotational deformity	55 (3.9%)	43 (3.9%)	12 (3.9%)	> 0.9	46 (18%)	15 (21%)	31 (17%)	0.5
Unknown	35 (2.5%)	27 (2.5%)	8 (2.6%)		22 (8.8%)	4 (5.6%)	18 (10%)	
Fracture displacement on radiograph of > 2 mm	373 (27%)	291 (26%)	82 (27%)	> 0.9	207 (83%)	63 (89%)	144 (81%)	0.14
Medical specialty				**< 0.001**				**< 0.001**
Trauma surgeon	1030 (73%)	832 (76%)	198 (65%)		167 (67%)	67 (94%)	100 (56%)	
Plastic surgeon	105 (7.5%)	41 (3.7%)	64 (21%)		72 (29%)	3 (4.2%)	69 (39%)	
Orthopedic surgeon	119 (8.5%)	93 (8.5%)	26 (8.5%)		10 (4.0%)	1 (1.4%)	9 (5.1%)	
Emergency physician	151 (11%)	133 (12%)	18 (5.9%)		0 (0%)	0 (0%)	0 (0%)	

* Pearson's chi-square test; Wilcoxon rank-sum test; Fisher's exact test. A p value of < 0.05 was taken as a threshold of statistical significance

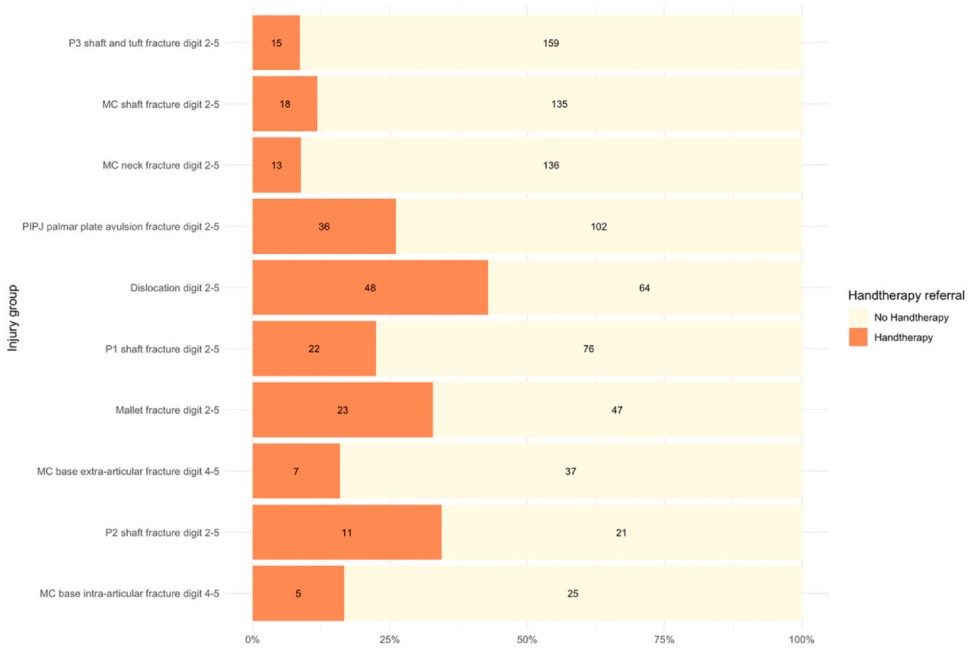

Fig. 1. Referral to hand therapy per injury category of the 10 most common injury categories treated non-operatively (in order of descending incidence). The bars represent the distribution, with the cumulative total reaching 100%. Absolute numbers corresponding to hand therapy and no hand therapy are specified for each injury category. P1 = proximal phalanx; MC = metacarpal; P2 = middle phalanx.

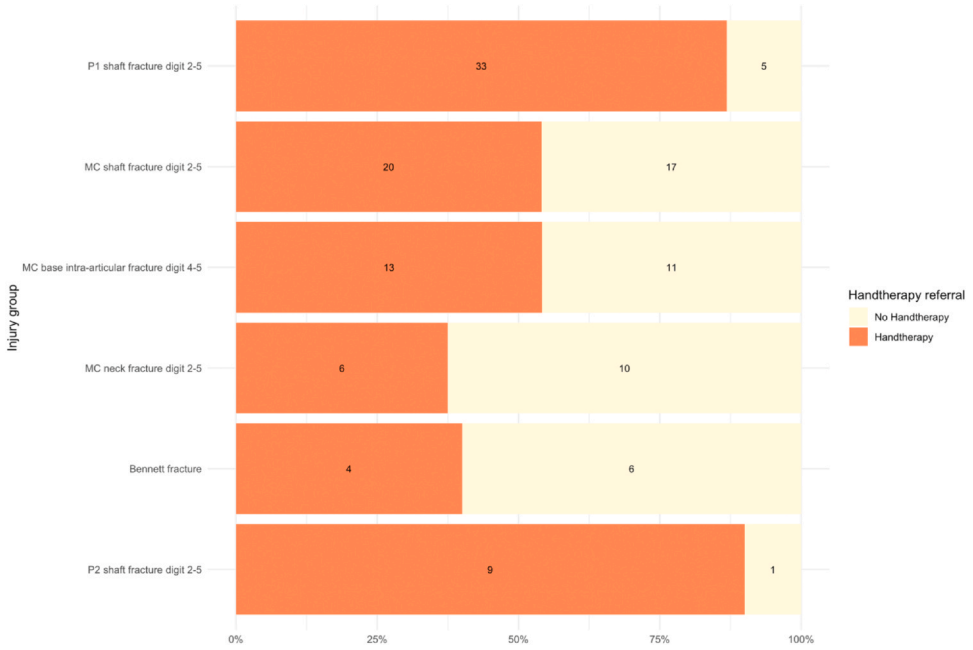

Fig. 2. Referral to hand therapy per injury category of the five most common injury categories treated operatively (in order of descending incidence). The bars represent the distribution, with the cumulative total reaching 100%. Absolute numbers corresponding to hand therapy and no hand therapy are specified for each injury category. MC = metacarpal; PIPJ = proximal interphalangeal joint; P1 = proximal phalanx; P2 = middle phalanx.

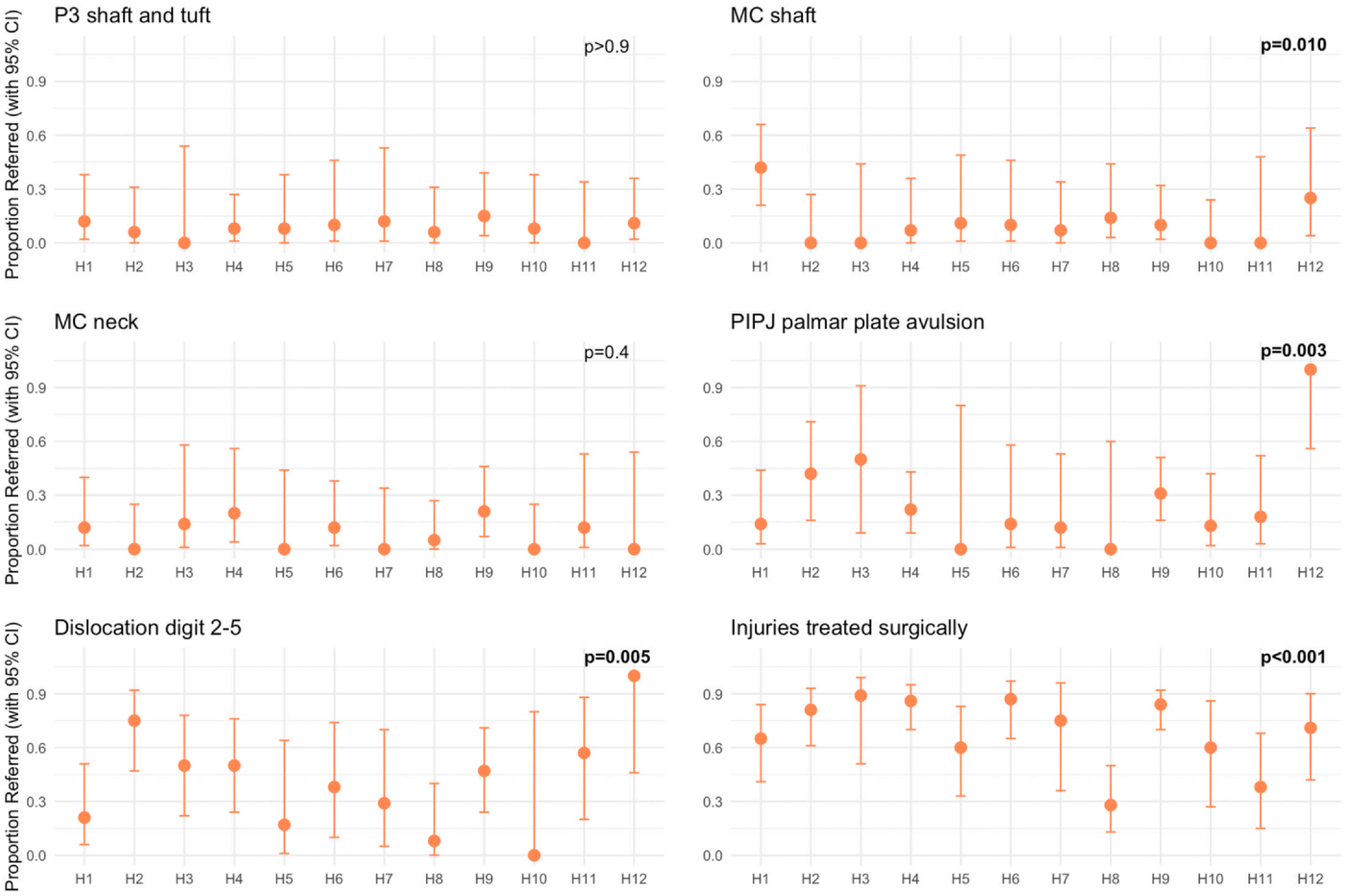

Fig. 3. Referral rates between hospitals for the five most common injury categories treated non-operatively and for operatively treated injuries. P3 = distal phalanx; MC = metacarpal; PIPJ = proximal interphalangeal joint; H = Hospital; CI = confidence interval.

Table 2
Multivariable logistic regression analysis to assess the impact of hospital variation on hand therapy referral for 1144 patients with one of the 10 most common injury types

	OR	95% CI	*p*-value
Treating hospital			**< 0.001**
H1	Ref		
H2	0.89	0.46–1.71	
H3	1.08	0.44–2.60	
H4	0.81	0.42–1.52	
H5	0.40	0.15–0.97	
H6	0.35	0.16–0.76	
H7	0.59	0.27–1.26	
H8	0.19	0.08–0.42	
H9	1.37	0.79–2.38	
H10	0.28	0.12–0.65	
H11	0.67	0.29–1.46	
H12	2.52	1.22–5.25	
Male sex	0.63	0.45–0.89	**0.008**
Age per year	1.01	1.00–1.02	0.2
Trauma mechanism			0.6
Low energy	Ref		
High energy	1.53	0.35–5.91	
Crush	0.76	0.39–1.47	
Hand comorbidity	0.79	0.46–1.33	0.4
Soft tissue damage	1.06	0.65–1.74	0.8
Clinically observed angulation	1.45	0.87–2.39	0.2
Clinically observed rotational deformity	0.53	0.26–1.06	0.074
Displacement on radiograph of > 2 mm	1.54	1.00–2.35	**0.048**
Treatment method			**< 0.001**
Non-operative treatment	Ref		
Operative treatment	9.73	5.75–16.9	
Injury categories			**< 0.001**
MC base intra-articular fracture digit 4-5	Ref		
MC base extra-articular fracture digit 4-5	1.37	0.42–4.21	
MC shaft fracture digit 2-5	1.15	0.50–2.70	
MC neck fracture digit 2-5	0.85	0.34–2.14	
P1 shaft fracture digit 2-5	3.17	1.37–7.58	
PIPJ palmar plate avulsion fracture digit 2-5	3.63	1.52–9.02	
P2 shaft fracture digit 2-5	7.10	2.53–20.5	
Mallet fracture digit 2-5	3.58	1.47–8.97	
P3 shaft and tuft fracture digit 2-5	0.92	0.33–2.55	
Dislocation digit 2-5	8.60	3.61–21.4	

OR = odds ratio, CI = confidence interval; MC = metacarpal; PIPJ = proximal interphalangeal joint; P1 = proximal phalanx; P2 = middle phalanx; P3 = distal phalanx. Results are presented as odds ratios with corresponding 95% confidence intervals. A p value of < 0.05 was taken as a threshold of statistical significance

Table 3
Multivariable logistic regression analysis to assess the impact of variation in treating specialism on hand therapy referral for 1144 patients with one of 10 most common injury types

	OR	95% CI	*p*-value
Medical specialty			**< 0.001**
Trauma surgeon	Ref		
Plastic surgeon	4.73	2.82–8.06	
Orthopedic surgeon	1.16	0.66–1.98	
Emergency physician	0.75	0.40–1.33	
Male sex	0.65	0.47–0.90	**0.009**
Age per year	1.00	1.00–1.01	0.3
Trauma mechanism			0.4
Low energy	Ref		
High energy	2.36	0.52–9.21	
Crush	0.79	0.41–1.48	
Hand comorbidity	0.71	0.42–1.18	0.2
Soft tissue damage	0.87	0.54–1.39	0.6
Clinically observed angulation	1.29	0.79–2.10	0.3
Clinically observed rotational deformity	0.73	0.37–1.40	0.4
Displacement on radiograph of > 2 mm	1.49	0.99–2.23	0.053
Treatment method			**< 0.001**
Non-operative treatment	Ref		
Operative treatment	7.34	4.47–12.3	
Injury categories			**< 0.001**
MC base intra-articular fracture digit 4-5	Ref		
MC base extra-articular fracture digit 4-5	1.20	0.39–3.48	
MC shaft fracture digit 2-5	1.09	0.51–2.44	
MC neck fracture digit 2-5	0.72	0.31–1.72	
P1 shaft fracture digit 2-5	2.61	1.19–5.92	
PIPJ palmar plate avulsion fracture digit 2-5	3.01	1.32–7.13	
P2 shaft fracture digit 2-5	4.62	1.74–12.6	
Mallet fracture digit 2-5	2.80	1.16–6.93	
P3 shaft and tuft fracture digit 2-5	0.86	0.32–2.29	
Dislocation digit 2-5	6.04	2.63–14.4	

OR = odds ratio; CI = confidence interval; MC = metacarpal; PIPJ = proximal interphalangeal joint; P1 = proximal phalanx; P2 = middle phalanx; P3 = distal phalanx. Results are presented as odds ratios with corresponding 95% confidence intervals. A p value of < 0.05 was taken as a threshold of statistical significance.

patients who were not referred to hand therapy this was 81 (IQR 60, 91) $p = 0.3$. These results, including the results of the MHQ subdomain scores, are presented in Figure 4A and 4B.

In multivariable linear regression analysis, referral to hand therapy was associated with a significantly worse MHQ score (coefficient −4.7, 95% CI: −9.2 to −0.18, $p = 0.042$). Male patients showed a significantly better MHQ score (coefficient 4.6, 95% CI: 0.75-8.5, $p = 0.020$). Each additional year of age was associated with decrease in the MHQ score, with a reduction of 0.18 points per year (95% CI: −0.29 to −0.07, $p = 0.002$). The presence of hand comorbidities was associated with worse MHQ scores (coefficient −10, 95% CI: −16 to −4.3, $p < 0.001$). The results are shown in Table 4.

Discussion

This multicenter cross-sectional study analyzed patterns in hand therapy referral for adult patients with hand fractures and dislocations in the Netherlands. The study found practice variation in referral to hand therapy within injury categories, which seems to be largely attributed to variations between hospital setting and medical specialty. Furthermore, being female, operative treatment and type of injury were associated with hand therapy referral. Patient-reported outcomes at 3 months post-injury of patients who were referred to hand therapy were lower compared to those who were not referred. When interpreting these results, it should be taken into account that multivariable logistic regression showed that older age and the presence of hand comorbidity were significantly associated with hand therapy referral. These factors could potentially result in lower overall scores or may impact the recovery process. Additionally, the limitations described in the next paragraph should also be considered. The results of this study underscore the knowledge gap and provide valuable insights to guide future studies.

The strengths of the study are its cross-sectional multicenter snapshot study design, which allowed the researchers to collect a large sample of data in a short time period to rapidly gain insight into the current practice. This study design has been successfully used in the past for research in abdominal surgery.[17] Including all patients presenting to the ED limited the risk of selection bias. This study has several limitations. First, no data were available on the actual hand therapy trajectory and it was not possible to identify patients who were referred to hand therapy but did not attend hand therapy. This lack of specificity may have resulted in a higher number of patients who were referred compared to the number of patients who actually received hand therapy. This may also have potentially influenced the patient-reported outcomes. Nonetheless, based on our experience in daily practice, it is unlikely that this affected a significant number of patients. Furthermore, this study only assessed hand therapy referral vs no referral, excluding patients who followed home exercise programs, which is emerging as a new treatment strategy. Second, MHQ scores were only available for 30% of the patients; therefore, outcomes might not be representative of the whole population. When interpreting the results, the differences in baseline characteristics between patients who completed the

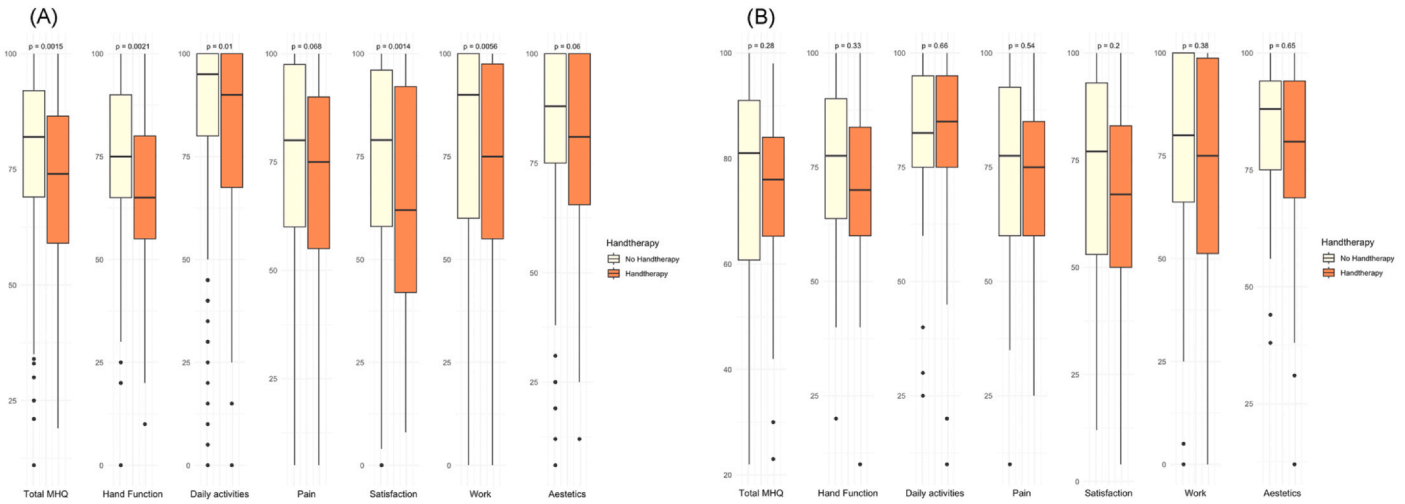

Fig. 4. A comparison of MHQ scores 3 months after injury stratified by hand therapy referral status, following non-operative treatment **(A)** and operative treatment **(B)**. Results are presented as boxplots, 0 indicating severe disability and 100 indicating no disability. A Wilcoxon rank-sum test was used to calculate *p*-values.

Table 4
Multivariable linear regression for MHQ score of 337 patients for the 10 most common injuryies types

Characteristic	Coefficient	95% CI	*p*-value
Referral to hand therapy	−4.7	-9.2–-0.18	**0.042**
Male sex	4.6	0.75–8.5	**0.020**
Age per year	−0.18	-0.29–-0.07	**0.002**
Trauma mechanism			0.5
Low energy	Ref		
High energy	11	-9.0–31	
Crush	−0.41	-7.2–6.4	
Hand comorbidity	−10	-16–-4.3	**< 0.001**
Soft tissue damage	−4.9	-11–0.81	0.092
Clinically observed angulation	−0.54	-6.9–5.8	0.9
Clinically observed rotational deformity	−4.9	-13–3.5	0.3
Displacement on radiograph of > 2 mm	0.51	-4.4–5.4	0.8
Treatment method			0.8
Non-operative treatment	Ref		
Operative treatment	1.0	-5.4–7.5	
Injury categories			0.2
MC base intra-articular fracture digit 4-5	Ref		
MC base extra-articular fracture digit 4-5	−2.0	-14–10	
MC shaft fracture digit 2-5	−1.6	-11–8.1	
MC neck fracture digit 2-5	−2.9	-13–7.5	
P1 shaft fracture digit 2-5	5.8	-4.3–16	
PIPJ palmar plate avulsion fracture digit 2-5	2.7	-8.0–13	
P2 shaft fracture digit 2-5	6.1	-9.0–21	
Mallet fracture digit 2-5	1.5	-9.6–13	
P3 shaft and tuft fracture digit 2-5	6.2	-4.5–17	
Dislocation digit 2-5	5.5	-5.1–16	

MC = metacarpal; PIPJ = proximal interphalangeal joint; P1 = proximal phalanx; P2 = middle phalanx; P3 = distal phalanx; CI = confidence interval.
Results are presented as regression coefficients with corresponding 95% confidence intervals. A negative score indicates that the factor is associated with a worse MHQ score. For every one-unit increase in the predictor variable, the outcome variable will increase by the coefficient value. A p value of < 0.05 was taken as a threshold of statistical significance.

MHQ and patients who did not complete the MHQ, as presented in Supplementary Table 1, should be taken into account. In addition, MHQ scores were only assessed at 3 months. This suggests that in some cases the hand therapy trajectory might not be completed, which are often the more severe cases. Lastly, this study reflects the current practice in the Netherlands, which might not be representative of other countries. However, it can be interesting to compare the results of different countries to identify if similar patterns exist.

Regarding non-operatively treated injuries, we found practice variation in referral rates within injury categories. For example, 43% (48/115) of patients with dislocations of digits two to five were referred to hand therapy, meaning that more than half of the patients with the same injury were not referred. As shown in Tables 2 and 3, part of this variation is likely due to differences in hospital settings and medical specialties. It is suspected that local hospital protocols differ due to the absence of evidence-based treatment recommendations. Studies evaluating the role of hand therapy in the recovery of non-operatively treated hand fractures are limited.[10,11,18] A systematic review by Sheerin et al, evaluating the effectiveness of occupational therapy interventions on function and occupational performance among adults with conditions of the hand, wrist, and forearm, found that occupational therapy interventions improve function, occupational performance, and pain, even though the evidence remains of low to moderate certainty.[11] A systematic review on non-operatively and operatively treated extra-articular proximal phalangeal fractures concluded that none of the included studies compared different rehabilitation modalities.[18] Furthermore, a retrospective study on non-operatively treated fifth MC fractures suggests that these fractures can be managed effectively through an ED protocol without any formal orthopedic follow-up.[19] Collectively, these studies highlight the need for further research to determine which patients and injuries benefit most from hand therapy.

Regarding operatively treated patients, the overall referral rate was 72% (178/249), and referral rates between hospitals ranged from 28% (95% CI: 13%-50%) to 89% (95% CI: 51%-99%). These results are contradictory to the Dutch guideline for hand fractures recommending hand therapy referral for the majority of fractures treated operatively.[7] However, these recommendations are based on limited available evidence.[6,20] A randomized controlled trial on postoperative treatment of MC fractures evaluating classical physical therapy compared with a home exercise program showed that both methods were effective. No differences were found in outcomes; however, this may be due to limitations in the study design and the small sample size.[21] Another randomized trial evaluating the

effectiveness of constrained and unconstrained exercises after proximal phalangeal fracture fixation found no difference between the two types of exercise.[22] Furthermore, a systematic review of upper limb fractures found evidence that current prescribed exercise regimens may not be effective in reducing impairments and improving activity. They reported that starting exercise early combined with a shorter immobilization period is more effective than starting exercise after a longer immobilization period.[23] These results suggest that, even for the most prevalent injury types treated operatively, the literature is inconclusive on which rehabilitation strategy is needed.

Patients referred to hand therapy had a lower median MHQ score 3 months following injury compared to those not referred. It is important to notice that these results should not be interpreted as a causal effect of hand therapy and that no conclusions could be drawn about the effectiveness of hand therapy. Several factors could contribute to the observed difference in MHQ scores. For example, multivariable regression analysis showed that older age and the presence of hand comorbidity were both associated with a worse MHQ score. Additionally, factors such as psychological aspects, education level, and socio-economic status could impact the MHQ outcome.[24,25] Future research, such as a natural experiment observational study comparing MHQ scores within specific injury categories and including data on psychological aspects, education level, and socio-economic status, would help to better understand the relationship between hand therapy referrals and patient outcomes. Also, different outcome measurements could be included, as recommended by the International Consortium for Health Outcomes Measurement.[13]

Furthermore, the finding of a statistically significant difference in the MHQ outcomes between patients treated non-operatively with and without hand therapy referral does not necessarily imply clinical significance. When compared to the normative MHQ scores of 93 points after unilateral hand trauma reported in a previous study, the MHQ scores of 82 without hand therapy referral and 74 for those with hand therapy referral suggest that most patients in both groups did not achieve full recovery at 3 months post-injury.[26] This study did not include baseline or long-term MHQ scores which would be valuable for assessing and comparing changes over time to better understand the trajectory of recovery and ramifications for ongoing care needs for both groups.

The findings of this study revealed practice variation in referral to hand therapy within injury categories which seems to be largely attributed to hospital setting and medical specialty. Given the limited availability of high-quality research and the reliance on expert opinion in the Dutch guidelines, these results can be used for future research aimed at determining the most effective therapy regimens. Future studies should aim to identify patients who will benefit most from hand therapy, as well as those who will recover without traditional hand therapy through instructions for self-exercise at home or no exercise at all, to optimize resource utilization. Hand therapy has additional health care costs; however, the duration of impaired hand function and the related costs should also be taken into account. Until the results of high-quality studies have been reported, the decision to refer to hand therapy following fractures and dislocations of the hand should be based on clinician's expert opinion, the outcomes of this study, the patient's preferences, and the context of the rehabilitation environment.

Author Contributions

Marco Ritt: Writing—review and editing. Mark van Heijl: Writing—review and editing, Supervision, Methodology, Conceptualization. Rolf Groenwold: Writing—review and editing, Methodology. Niels Schep: Writing—review and editing, Supervision, Methodology, Conceptualization. Louise de Haas: Writing—review and editing, Writing—original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Charlotte Lameijer: Writing—review and editing. Veronique van de Lucht: Writing—original draft, Methodology, Formal analysis, Conceptualization.

Declaration of Competing Interest

None.

Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jht.2024.12.014.

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JHT Read for Credit
Quiz: # B86

Record your answers on the Return Answer Form found on the tear-out coupon at the back of this issue. There is only one best answer for each question.

#1. Subjects included patients with
a. phalangeal Fxs
b. metacarpal Fxs
c. dislocations
d. any of the above

#2. The distribution of patients was
a. not reported
b. equal numbers of non op and post op
c. many more post op than non op
d. many more non op than post op

#3. The most common injury referred to hand therapy was
a. dislocations
b. metacarpal Fxs
c. phalangeal Fxs
d. crush

#4. Referrals to hand therapy in this study came from
a. orthopedic surgeons
b. emergency room physicians
c. board certified hand surgeons
d. family doctors

#5. More females were referred to hand therapy than males
a. false
b. true