Observational Studies

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Mediating effect of catastrophising in correlation between pain and disability amongst patients with carpal tunnel syndrome

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Abstract

Objectives: To examine the mediating role of catastrophizing in the relationship between pain and disability among patients with carpal tunnel syndrome (CTS).
Methods: Cross-sectional register of 141 patients with CTS. Pain Catastrophizing Scale (PCS) was used. Mediation analysis was used to assess the indirect effect of pain catastrophizing on pain-related disability.
Results: The average age was 54.0 (SD 16.1) years and 89 (63 %) were women. For the total PCS score, the indirect effect was responsible for 31 % (95 % CI 15 %–47 %) to 33 % (95 % CI 15 %–52 %). The highest proportion was observed in the helplessness domain, 37 % (95 % CI 19 %–55 %). The lowest effect of 11 % (95 % CI 0 %–23 %) was seen for the magnification domain.
Conclusions: The mediating effect of catastrophizing was responsible for over 30 % of the total effect seen in correlation between pain and disability experienced by patients with CTS. While the effect of magnification sub-score was borderline and could probably be ignored in clinical context, domain of helplessness reached the effect size of almost 40 %. The results suggest that catastrophizing should be considered when treating or rehabilitating people with CTS. Catastrophizing may play a significant role in the development of pain-related disability.

Keywords: pain catastrophizing level; disability; upper extremity pain; chronic pain; mediation

Introduction

Carpal tunnel syndrome (CTS) is the most common focal neuropathy, affecting approximately 1–5% of the general population [1]. CTS is more prevalent in women than men, with a 3:1 ratio [1]. It manifests through pain, numbness, and tingling in the hands, often leading to significant functional impairment and reduced quality of life [2, 3]. While physical factors, such as compression of the median nerve, play a primary role in CTS pathophysiology, psychological factors like catastrophizing are increasingly recognized as key mediators in the experience of pain and associated disability [3–5]. Research has demonstrated that patients who engage in catastrophizing tend to experience greater levels of disability and require more time to achieve rehabilitation milestones during recovery from surgery [6–12].

Hypothetically, a mediating effect occurs when a third variable partially or fully accounts for the relationship between two other variables [13]. Various factors have been examined as possible mediators in the link between pain and disability: acceptance of pain, guilt, pain catastrophizing, fear, depression, physical activity, patient education, self-efficacy and pain beliefs [14–17]. While pain has been commonly linked to disability, the exact mechanisms by which pain leads to disability are not well understood [18, 19]. Additionally, the strength and direction of this relationship have not always been clear, and some previous studies have reported significant, but no or only weak association between pain and self-reported disability [20, 21].

Turner et al. examined pain catastrophizing in a group of 174 individuals with chronic pain due to spinal cord injuries [22]. The results indicated that those with higher levels of pain catastrophizing also reported significantly higher levels of psychological distress and pain-related disability. In another study, Severeijns et al. investigated the relationship between catastrophizing and pain intensity, pain-related

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disability, and psychological distress in a group of 211 patients with chronic pain [23]. The major finding of that study was that catastrophizing appears to be an important factor in the chronic pain experience as a potent predictor of pain intensity, disability, and psychological distress. A study by Lozano Calderon et al. regarding patients with carpal tunnel syndrome found that elevated Pain Catastrophizing Scale (PCS) scores were significantly associated with greater functional impairment reflected in higher Disabilities of the Arm, Shoulder, and Hand questionnaire (DASH) scores, even though no significant relationship was seen between PCS scores and patient-reported treatment satisfaction [24].

Overall, the results of earlier studies indicate that catastrophizing may play a significant role in pain-related disability. However, the mediating role of catastrophizing in the correlation between pain and disability in particular among people with CTS remains uncertain and the objective was to examine this role. The hypothesis was that the correlation between pain severity and disability level can be partly credited to pain catastrophizing. The findings may contribute to the development of more targeted treatment strategies of CTS, not only focusing on physical symptoms but also considering psychological factors, such as catastrophizing.

Methods

This was a retrospective cross-sectional register-based study. The study sample was derived from a register kept by the Wellbeing Services County of Southwest Finland. The study has been approved by the research department of Wellbeing Services County of Southwest Finland (2024-1208-TL). According to the Finnish legislation, a retrospective register-based study does not require a formal informed consent from a participant. The data were provided to the research group in an anonymous form without any individually identifiable information. Before every visit at the department of hand surgery of a university clinic, all the patients had received a link to a survey, which contains questions regarding demographics, pain and functioning. At the beginning of June 2024, the entire register contained data on 14,095 patients. Of them, 141 patients have had diagnosis of CTS (G56.0) as the main reason for visiting the clinic and they have responded to all three scales: the PCS, the QuickDASH and a pain numeric rating scale (NRS) between February 14, 2019 and June 3, 2024. The responses were usually given before the first visit to the clinic. The study sample only included patients who were deemed eligible for surgical intervention based on clinical history and ENMG findings. If these criteria were not met, a referral was returned.

Sex was dichotomized as men vs. women. Hand domination was classified into three groups: right, left, and ambidextrous. Educational level was dichotomized as 'high school' vs. 'no high school'. Physical activity was categorized into four levels: none, 3 h/week, 4 h/week, and more than 4 h/week. Age was defined in full years at the time of the first visit to the clinic. Body mass index (BMI) was calculated as body weight divided by squared body height and expressed in kg/m^2.

Pain catastrophizing scale (PCS)

The PCS questionnaire was used to evaluate the degree of pain catastrophizing. The PCS is a 13-item scale, with each item rated on a five-point Likert-like scale from zero (not at all) to four (all the time). In addition to a total score, the PCS produces scores for its three subscales: magnification, rumination, and helplessness. The sub-scores are the sums of responses to items 8, 9, 10 and 11 (rumination), 6, 7 and 13 (magnification) and 1, 2, 3, 4, 5 and 12 (helplessness). The overall score is a sum all 13 item responses ranging from 0-52, higher scores indicating a greater degree of pain catastrophizing. A total score of >30 is usually considered a clinically significant level of pain catastrophizing.

Quick disabilities of arm, shoulder & hand (QuickDASH)

The QuickDASH questionnaire was used to evaluate the limitations in different types of everyday activities caused by the symptoms in an upper extremity. QuickDASH contains 11 items assessed on a Likert-like scale from one (no limitation) to five (most severe limitation). The total score was calculated as ([(sum of n responses)/n] – 1) * 25, where "n" is equal to the number of completed responses. The QuickDASH score was considered missing if there was more than one missing item response. The total score of QuickDASH ranges from 0 (no disability) to 100 (most severe disability). If there was more than one response to the QuickDASH, then the first one was included.

Pain numbering rating scale (NRS)

Pain severity in upper extremity was assessed by using a NRS from zero (no pain) to 10 (most severe pain).

Statistical analysis

Based on pain severity, participants were divided into three groups of equal size: groups with mild, moderate, and severe pain. The descriptive statistics were reported as means and standard deviations (SD) or as frequencies and percentage, when appropriate. Differences in descriptive statistics between groups with different pain severity were assessed using a linear regression (for continuous variables) or Chi^2 test (for categorical variables). The correlations between pain, disability and catastrophizing scores were assessed by using Pearson correlation coefficients and the results were interpreted as follows: weak < 0.30; moderate < 0.50; strong < 0.70; and very strong ≥ 0.70.

Mediation analysis evaluated the indirect effect of arm pain intensity on disability severity via catastrophizing level. The mediation analysis produced figures describing the direct and indirect effects as well as the total effect (the sum of direct and indirect effects) (Figure 1). In mediation analysis, direct effect defined the effect of pain on disability through mechanisms other than the studied mediator (here catastrophizing). In turn, indirect effect described the effect of pain on disability through the mediator (here catastrophizing). The results were reported as linear regression coefficients and as percentage of indirect effect out of total effect (100 %). The results were accompanied by 95 % confidence intervals (95 % CIs) and they were also presented graphically.

All the analyses were conducted using Stata/IC Statistical Software: Release 18. College Station (StataCorp LP, Texas, USA).

Results

The descriptive characteristics of the sample are shown in Table 1. Of 141 respondents, 89 (63 %) were women. The average age was 54.0 (SD 16.1) years and BMI was 29 (SD 6.7) kg/m^2. Of the respondents, 36 % had completed high school. For the entire sample, NRS pain score was 5.0 (SD 2.9) points, the PCS score was 16.0 (SD 12.0) points and the QuickDASH score was 41.0 (SD 21.8) points.

All the correlations between pain, disability and catastrophizing scores were positive and moderate to strong (Table 2).

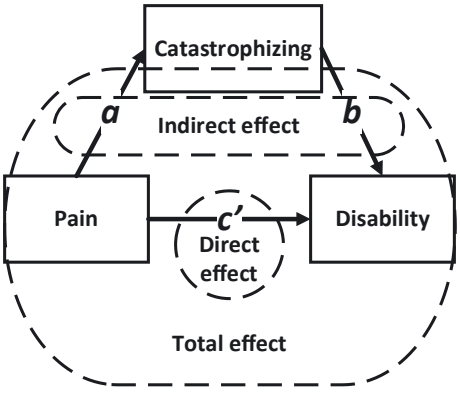

Figure 1: Logic behind the mediating effect of catastrophizing in this study.

Table 1: Descriptive characteristics of sample.

Characteristics	Pain level			Total	p-Value
	Mild n=47 (33 %)	Moderate n=47 (33 %)	Severe n=47 (33 %)	n=141 (100 %)	
Sex					0.673
Men	19 (40 %)	15 (32 %)	18 (38 %)	52 (37 %)	
Women	28 (60 %)	32 (68 %)	29 (62 %)	89 (63 %)	
Domination					0.338
Right	41 (87 %)	44 (94 %)	46 (98 %)	131 (93 %)	
Left	5 (11 %)	2 (4 %)	1 (2 %)	8 (6 %)	
Ambidextrous	1 (2 %)	1 (2 %)	0 (0 %)	2 (1 %)	
Educational status					0.008
No high school	21 (46 %)	32 (71 %)	34 (74 %)	87 (64 %)	
High school	25 (54 %)	13 (29 %)	12 (26 %)	50 (36 %)	
Physical activity					0.200
None	11 (24 %)	16 (34 %)	7 (15 %)	34 (24 %)	
3 h/week	9 (20 %)	4 (9 %)	6 (13 %)	19 (14 %)	
4 h/week	25 (54 %)	24 (51 %)	32 (70 %)	81 (58 %)	
>4 h/week	1 (2 %)	3 (6 %)	1 (2 %)	5 (4 %)	
Age, years	53 (16.0)	55 (16.1)	54 (16.4)	54 (16.1)	0.858
BMI, kg/m^2	28 (7.7)	29 (6.6)	28 (5.5)	29 (6.7)	0.815
Pain severity, points	2 (1.3)	6 (1.1)	8 (0.7)	5 (2.9)	<0.001
QuickDASH, points	25 (17.9)	40 (19.6)	57 (15.7)	41 (21.8)	<0.001
PCS total, points	9 (9.8)	16 (11.1)	23 (11.0)	16 (12.0)	<0.001
Rumination, points	4 (3.9)	6 (3.8)	9 (4.3)	6 (4.5)	<0.001
Magnification, points	2 (1.8)	3 (2.4)	4 (2.7)	3 (2.5)	<0.001
Helplessness, points	4 (4.7)	7 (5.6)	11 (5.4)	7 (5.9)	<0.001

Continuous variables reported as means (standard deviations). Two-tailed p-values obtained either from Chi squared test or from linear regression.

Table 2: Correlations between variables of interest and both pain and QDASH score.

Variable	Pain			QuickDASH		
	r	95 % CI		r	95 % CI	
QuickDASH	0.64	0.53	0.73	–	–	–
Rumination	0.45	0.31	0.57	0.50	0.36	0.61
Magnification	0.37	0.22	0.51	0.41	0.27	0.54
Helplessness	0.50	0.36	0.61	0.60	0.48	0.70
PCS total	0.49	0.35	0.60	0.57	0.44	0.67

Table 3 and Figure 2 show the percentage contribution of the indirect mediating effect to the total effect of pain on disability. Overall, when looking at the results of the entire PCS measure, the indirect effect was responsible for 31 % (95 % CI 15 %–47 %) of the total effect in the comparison of moderate vs. mild pain. The corresponding figure was 33 % (95 % CI 15 %–52 %) when comparing groups with severe vs. mild pain. For the domains, this percentage varied. At its lowest, it was 11 % (95 % CI 0 %–23 %) for the magnification domain when comparing groups with severe vs. mild pain. In this case, the result was therefore statistically insignificant. When comparing groups with moderate vs. severe pain, the proportion of the mediating effect in the magnification domain was 15 % (95 % CI 3 %–27 %). The highest proportion was observed in the helplessness domain, 37 % (95 % CI 19 %–55 %), also in this case when the comparison was between groups with severe vs. mild pain.

Discussion

This study examined the potential mediating role of pain catastrophizing in the relationship between pain and disability in a sample of 141 patients with CTS. Overall, for the total PCS score, the indirect effect was responsible for over 30 % of the total effect. The sub-domains contributed to this value to varying degrees. The largest effect size was demonstrated by the helplessness domain, where the effect size approached 40 %. The effect of rumination was on average around 25 %. Effect of magnification score was small and it can probably be ignored in this context – the effect size was borderline with lower confidence limit either zero or approaching zero. If confidence intervals are taken into account, the weakest possible effect for the PCS total score in the studied population was still at least 15 %. The corresponding weakest observed effect size for the helplessness domain would still be around 20 %.

Table 3: Indirect mediating effect of pain catastrophizing on disability caused by carpal tunnel syndrome expressed as % of total effect.

PCS domains/Pain groups	%	95 % CI	
Rumination			
Moderate vs. mild	23	8	38
Severe vs. mild	27	10	44
Magnification			
Moderate vs. mild	15	3	27
Severe vs. mild	11	0	23
Helplessness			
Moderate vs. mild	35	18	51
Severe vs. mild	37	19	55
PCS total			
Moderate vs. mild	31	15	47
Severe vs. mild	33	15	52

Generalization of these results may be weakened by a few issues. These data were cross-sectional, which always makes causal inference uncertain. A registry study is always limited in terms of the variables used. It is possible that variables outside the scope of the study (e.g. socioeconomic status, occupational strain, comorbidity, etc.) could have influenced both pain and disability, as well as the mediator itself. Considering the type of statistical method used in this study, the group of 141 patients can hardly be considered large in relation to the objectives. It should also be mentioned that the registry was created in a highly specialized unit of a tertiary care hospital. In practice, this has always been a surgical assessment. Certainly, catastrophizing is only one of many factors that have previously been found or suspected to have an effect on pain and disability. These other factors are psychological distress, acceptance of pain, guilt, fear, depression, physical activity, patient education self-efficacy and pain beliefs [14–17]. Unfortunately, these registry data did not contain information on them. Because this cohort consists of CTS patients referred to hospital for surgical evaluation, their symptom profile is likely more severe and longer-standing than those receiving conservative treatment in primary care. In this dataset, the gradual worsening of CTS symptoms and referral to hospital may heighten helplessness, rumination and magnification. The relationship between pain and disability and the importance of catastrophizing in this relationship may be more or less different in other settings, for example in primary care patients.

The exact same research question in a similar setting has not been studied before. However, some previous studies can be indirectly compared to the results of this study. In line with these results, catastrophizing has previously been found to play a significant role in the experience of pain and therefore in the disability caused by pain [4, 5]. For example, previous research has indicated that around 80 % of patients with trigeminal neuralgia may experience significant pain

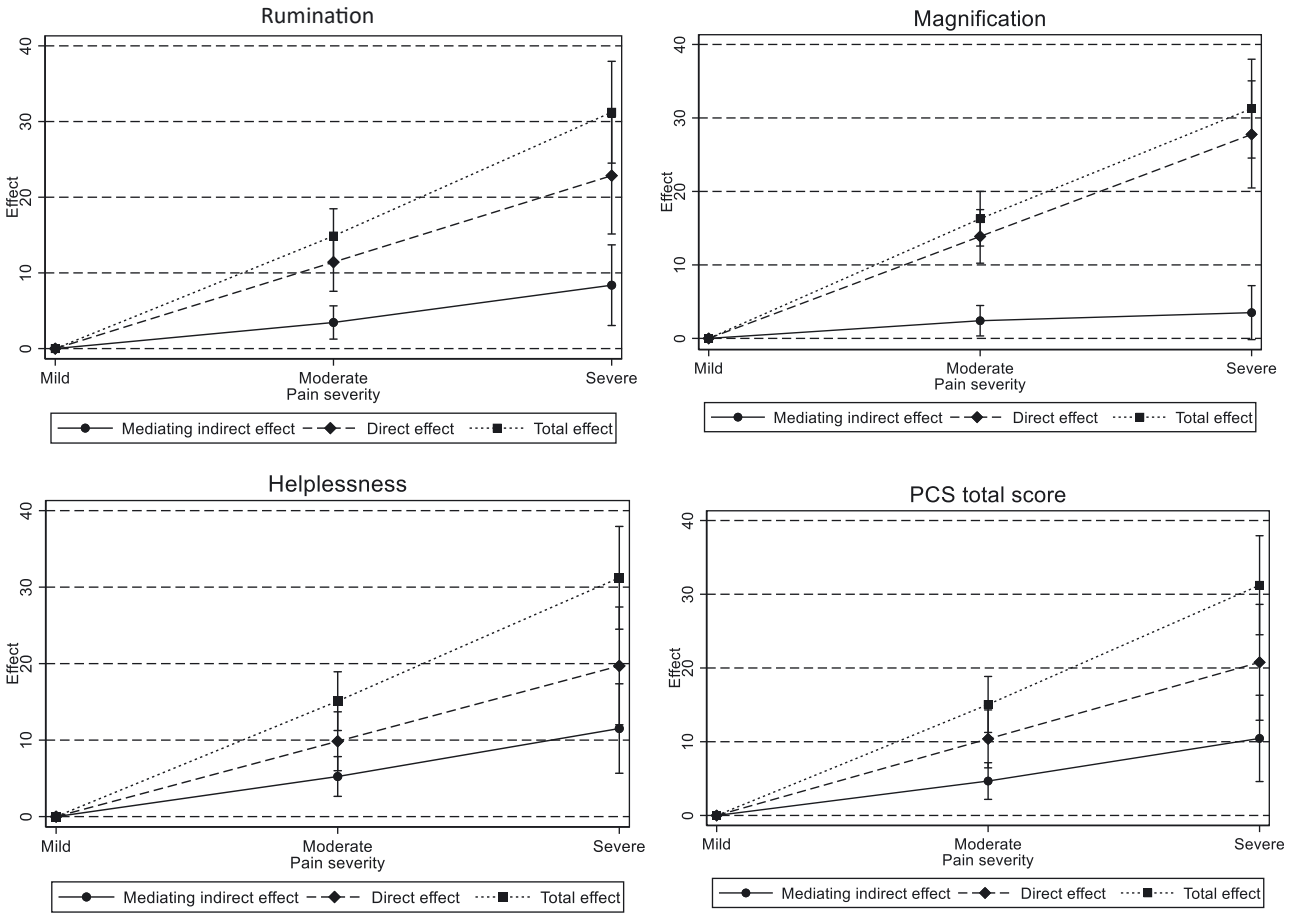

Figure 2: The indirect, direct and total effect of the mediators (rumination, magnification, helplessness and PCS total) on the relationship between pain across three different pain groups (mild, moderate and severe) and disability.

catastrophizing [25]. Previous studies have reported that more severe catastrophizing may be associated with worse CTS symptoms [26, 27]. Respectively, the level of catastrophizing has previously been noted to be associated with a more severe degree of disability in CTS patients [28].

When studying the mediating effects of the different dimensions of pain catastrophizing on outcomes in an interdisciplinary pain rehabilitation program, Gilliam et al. have reported that changes in three dimensions of pain catastrophizing differentially mediate improvement in pain outcome [29]. In line with the present results, helplessness and rumination, but not magnification, demonstrated strong and consistent mediating effect on treatment outcomes. Sullivan et al. have assessed the effect of catastrophic thinking associated with pain experience and disability in patients with neuropathic pain [30]. Also in that study, the PCS helplessness subscale was the only dimension of catastrophizing to contribute significantly to pain-related disability.

High catastrophizing scores may indicate fear of getting disable. This fear has been shown to mediate the relationship between pain and disability [16]. The fear of worsening functioning may also affect one's ability to manage financially, which may be accentuated as CTS is more common among manual workers with less income compared to higher socio-economic groups. Nocturnal symptoms and awakenings may worsen both the severity of perceived disability and the degree of catastrophizing. The low or non-existent weight of magnification in the catastrophizing reactions of CTS patients compared to rumination and helplessness may be explained by the fact that CTS is typically relatively easy to diagnose and its etiology is well known. Thus, patients usually have a good understanding of the cause of the condition and that the disease is usually treatable with relatively minor surgical intervention. Thus, patients are generally not afraid of malignancy or progressive neurological disease, which makes magnification less obvious. In contrast, CTS patients may feel that they have little ability to influence the gradually worsening symptoms associated with CTS, which may reinforce the role of helplessness in catastrophizing reactions.

The role of catastrophizing in the relationship between pain and disability in CTS patients requires further clarification. The results obtained in this study should be confirmed in larger datasets, at different levels of healthcare, and preferably with a wider range of variables. The evidence on the psychometric properties of the subscales of the PCS is more limited compared to the total scale, which might have an impact on the interpretation of the results. Thus, future research may provide valuable information also in this direction.

Conclusions

The mediating effect of catastrophizing was responsible for over 30 % of the total effect seen in correlation between pain and disability experienced by patients with CTS. While the effect of magnification sub-score was borderline and could probably be ignored in clinical context, domain of helplessness reached the effect size of almost 40 %. The results suggest that catastrophizing should be considered when treating or rehabilitating people with CTS. Catastrophizing may play a significant role in the development of pain-related disability.

Research ethics: The work described has been carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving. The privacy rights of human subjects have been observed according to the EU General Data Protection Regulation (GDPR). The study sample was derived from a register kept by the Wellbeing Services County of Southwest Finland. The study has been approved by the research department of Wellbeing Services County of Southwest Finland (2024-1208-TL). The data were provided to the research group in an anonymous form without any individually identifiable information.
Informed consent: According to the Finnish legislation, a retrospective register-based study does not require a formal informed consent from a participant.
Author contributions: All four authors substantially contributed to the conception, design, analysis, and interpretation of the work. MS and HT were responsible for the acquisition of data for the work. MS was responsible for the statistical analysis. VS was responsible for the drafting the work. All the authors substantially contributed to the reviewing the draft critically for important intellectual content and to the final approval of the version to be published. All the authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
Competing interests: None to declare.
Research funding: None to declare.
Data availability: Raw data are available from the corresponding author on a reasonable request.
Artificial intelligence/Machine learning tools: Not used.

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