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Manual therapy compared to surgery in the treatment of moderate carpal tunnel syndrome

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Abstract

Purpose: The objective of this study was to assess the efficacy of manual therapy, specifically using the Maitland concept, in treating carpal tunnel syndrome (CTS), and to compare its effectiveness with surgical decompression of the median nerve.

Methods: A total of 69 patients were enrolled and divided into two groups: a control group (undergoing surgery) and treatment group (receiving manual therapy). Subgroups were formed based on gender, considering factors such as grip strength. Inclusion criteria comprised active symptoms of CTS and electrophysiological evidence of nerve lesion. Exclusion criteria included diabetes, thyroid diseases, trauma to the upper limb, and pregnancy. Baseline and 10-12 month post-intervention assessments encompassed EQ-5D-5L, CTS6, DASH, grip strength and electrophysiological studies. The treatment group (43 patients) underwent five weekly manual therapy sessions. A physiotherapist individually assessed and treated patients, emphasizing passive techniques and prescribing home self-neuromobilization. The control group (26 patients) underwent carpal tunnel release surgery.

Results: Both surgical and manual therapy interventions significantly reduced symptom severity ($p < 0.001$). Manual therapy improved hand function in females ($p < 0.001$) and showed positive trends in the control group. The treatment group demonstrated higher grip strength, with significant improvements in females ($p < 0.001$). Quality of life also improved in females ($p < 0.001$). No significant differences in distal motor latency though sensory latency showed positive trends in females.

Conclusions: This research offers a comprehensive understanding of the effectiveness of manual therapy and surgical release in treating CTS. The findings suggest that both interventions can result in improvements in grip strength and quality of life with variations in based on gender and specific outcome measures.

Key words: carpal tunnel syndrome, manual therapy, open carpal tunnel release, Maitland therapy.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a condition that can affect people of all ages and lifestyles. While it is often associated with activities involving repetitive hand movements, CTS may also be caused by other factors, such as autoimmune diseases, hormonal imbalances, or metabolic disorders. Additional risk factors include exposure to vibrations, prolonged wrist flexion or extension, and repetitive hand movements [1]. Congenital [2-4] and traumatic changes [5] in the dimensions of the carpal tunnel are also potential contributors to CTS development. A reduction in the space within the carpal tunnel, which disrupts the spatial relationships between its structures, is the primary feature of CTS [6]. Different etiological factors ultimately lead to a reversal in the pressure gradient within the carpal tunnel, which hinders blood flow and axonal transport, causes nerve swelling, releases pro-inflammatory mediators, and inserts abnormal ion channels. Symptoms of CTS, such as pain, numbness in the hand, and difficulty moving the fingers and wrist joint, can significantly impact the quality of life and the patient's ability to perform daily tasks [1].

Open release is a surgical procedure commonly used to treat CTS. It involves cutting the transverse carpal ligament to relieve the pressure on the median nerve.

However, the invasiveness of this procedure has prompted researchers to explore less invasive alternatives, such as manual therapy.

Manual therapy is a hands-on approach that involves the manipulation and mobilization of joints, muscles, and soft tissues. The Maitland concept, developed by Australian physiotherapist Geoffrey Maitland, focuses on assessing and treating specific joint dysfunctions using graded, passive mobilization techniques. This approach aims to restore normal joint mechanics, reduce pain, and improve overall function. The proposed effect of using manual therapy for treating CTS is multifactorial. Firstly, these techniques aim to improve joint mobility and reduce restrictions, which can help alleviate the compression on the median nerve [2]. Moreover, manual therapy has been shown to have analgesic effects [3, 4], potentially reducing the pain associated with CTS. Furthermore, manual therapy may also facilitate an improvement in blood flow and lymphatic drainage, promote tissue healing, and reduce inflammation in the affected area [5].

This study aimed to compare the effectiveness of manual therapy using the Maitland concept for treating CTS versus surgical decompression of the median nerve. While growing evidence supports the use of manual therapy in managing CTS, there remains a need for high-quality research to establish its efficacy and determine its optimal application. This research paper aims to contribute to the existing body of knowledge by conducting a quasi-randomized controlled trial that compares the effectiveness of Maitland's concept of manual therapy with surgical treatment for moderate CTS.

METHODS

Sixty-nine patients were included in this study and divided into two groups: (1) a control group that underwent surgical decompression of the median nerve and (2) a treatment group that received manual therapy according to the Maitland concept. All patients enrolled in this study qualified for surgery, and manual therapy was administered during the waiting period. Patients were sequentially allocated to each group as they presented for treatment, ensuring random allocation. These groups were then further subdivided into male and female subgroups due to differences in certain attributes, mainly grip strength. Inclusion criteria comprised active symptoms of CTS and electrodiagnostic findings indicative of CTS, including sensory latency difference of more than 0.4 metres per second compared to the ulnar nerve (median – ulnar comparison), distal motor latency greater than 4.2 ms, and reduced conduction velocity. Exclusion criteria were diabetes, thyroid diseases, upper limb trauma in the past 12 months, and pregnancy. Patients with absent sensory responses from the median nerve were excluded from the study based on findings of Ashraf *et al.* [6], which suggested that no improvement is possible in such cases after conservative treatment. Thus, patients included in this study had moderate CTS according to the Padua scale.

Patients were assessed at baseline and 10-12 months post-intervention based on several measures: the EuroQol 5-dimension 5-level (EQ-5D-5L) scale for their health-related quality of life (QOL) [7], the Carpal Tunnel Six Questionnaire (CTS6) for the assessment of symptom severity [8, 9], the Disabilities of Arm, Hand, and Shoulder (DASH) questionnaire, which is a patient-reported outcome measure for upper limb function [10-12], a dynamometer for grip strength measurements [13-15], and an electrophysiological study [16-18] of the median nerve to measure distal motor latency of motor fibers and sensory distal latency of the sensory fibers. An experienced neurologist in the Neurology Clinic at The Medical University of Bialystok Clinical Hospital performed electrophysiological studies before and 10-12 post-treatment. Nerve conduction studies were performed using the antidromic technique for sensory conduction of the median nerve with the index finger as the focus. During the course of our study, we focused solely on measuring changes in the electrophysiological properties of the median nerve, without comparing them to the ulnar nerve. During the tests, skin temperature was maintained within the standard range. Strength measurements were taken with a physiotherapist's assistance to ensure the accuracy of the measurement method. Questionnaires were self-reported; the scales and questionnaires used were validated in Polish.

The treatment group consisted of 43 patients who underwent a cycle of five therapies for five weeks – one therapy per week. On the first treatment day, the patients were examined by a physiotherapist, discussed their medical history, and underwent a physical examination after which a treatment plan for each individual was established. The therapist and patients were not blinded because the assumption was to mirror the clinical conditions as closely as possible, including medical history and physical examination. One therapist was involved in the treatment process of the whole group. The therapy consisted of passive treatment including, but not limited to, carpal joint mobilizations, sliders, and tensioners of the median and ulnar nerves, cervical lateral glide, and mobilizations in the regions of the scalene triangle and subpectoral space. The only exercise performed by the patients at home was self-neuro-mobilization of the median nerve.

The control group consisted of 26 patients who received open carpal tunnel release surgery at the Orthopaedics Clinic of The Medical University of Bialystok Clinical Hospital. The initial assessment was conducted by a physiotherapist before surgery and the same physiotherapist took the second measurement 10-12 months post-surgery. Patients in the control group received information regarding post-surgical immobilization time and wound care based on their post-operative status. No adverse events following surgical carpal tunnel release were observed during the follow-up period in any of the patients.

The significant difference in gender distribution between the control group and the treatment group (as shown in Table 1) could potentially confound the results and impact the interpretation of the study. To reduce the risk of confounding, subgroup analyses were conducted to examine treatment effects within each gender group.

Written consent was acquired from patients before treatment initiation, and the study was approved by the Bioethics Committee of the Medical University in Białystok, with approval number APK002.173.2021.

The distribution of sociodemographic and anthropometric parameters for the total sample and the individual groups is shown in Table 1.

Statistical analysis

Analyses were conducted using the R Statistical language (version 4.1.1; R Core Team, 2021).

Linear mixed regression models (LMMs) were fitted to estimate the effects of patients' age, sex, time, and groups on the numerical response variable of each of the parameters studied. Subjects' identification numbers (IDs) were included in the model as a random intercept.

Including the dominant hand factor in the models did not produce any significant main effects, so the factor was not included in the final models. The main effect was reported for the covariate patient age, and the interaction effects were reported for the dichotomous factors, namely, sex, time, and group.

RESULTS

The effects of therapy on symptom severity

Both surgical intervention and manual therapy had a positive impact on reducing symptoms. The contrast analysis indicated significant differences in the change from baseline to post-treatment in the control group (male: $p < 0.001$; female: $p < 0.001$) and the treatment group (male: $p = 0.031$; female: $p < 0.001$) with no significant differences between the groups at baseline and post-treatment (Table 2).

The effects of therapy on hand function

Manual therapy led to improvements in females ($p < 0.001$), while both the male and female control groups showed a trend toward a significant difference (male: $p = 0.061$; female: $p = 0.083$). The contrast analysis revealed significant changes from baseline to post-treatment in the treatment group, with no differences between the groups at baseline or post-treatment.

The effects of therapy on grip strength

The results show that the treatment group had higher grip strength values compared to the control group at baseline. A small reduction in grip force was observed in the male treatment group. The contrast analysis revealed significant differences between the female treatment group ($p < 0.001$) and both the male and female control groups (male: $p = 0.024$; female: $p = 0.018$) at baseline and

Table 1. Distribution of demographic and clinical characteristics between treatment groups

	Group			p[1]
Parameter	**Overall, *N* = 69**	**Control, *n* = 26**	**Treatment, *n* = 43**	
Age, years	51.0 (42.0, 56.0)	49.5 (45.2, 55.0)	51.0 (42.0, 61.5)	0.771
Up to 51.0 years	37.0 (53.6%)	14.0 (53.8%)	23.0 (53.5%)	
Over 51.0 years	32.0 (46.4%)	12.0 (46.2%)	20.0 (46.5%)	
Sex				
Female	55.0 (79.7%)	16.0 (61.5%)	39.0 (90.7%)	0.004
Male	14.0 (20.3%)	10.0 (38.5%)	4.0 (9.3%)	
Which hand is affected by CTS:				
Both	48.0 (69.6%)	14.0 (53.8%)	34.0 (79.1%)	0.092
Left	6.0 (8.7%)	3.0 (11.5%)	3.0 (7.0%)	
Right	15.0 (21.7%)	9.0 (34.6%)	6.0 (14.0%)	
Is the affected upper extremity dominant?				
No	28.0 (40.6%)	8.0 (30.8%)	20.0 (46.5%)	0.197
Yes	41.0 (59.4%)	18.0 (69.2%)	23.0 (53.5%)	

[1] *Fisher's exact test*

Table 2.1. Estimated marginal means (EMMs) of CTS6 scores by treatment group, time point, and gender

Sex	Time	Group	EMMs of CTS6 score
Female			
	Baseline	Control	11.09
		Treatment	12.37
	Post-treatment	Control	5.4
		Treatment	4.62
Male			
	Baseline	Control	9.63
		Ttreatment	9.51
	Post-treatment	Control	4.78
		Treatment	5.14

Table 2.3. Estimated marginal means (EMMs) of dash scores by treatment group, time point, and gender

Sex	Time	Group	EMMs of DASH score
Female			
	Baseline	Control	35.92
		Treatment	35.20
	Post-treatment	Control	29.96
		Treatment	21.66
Male			
	Baseline	Control	23.62
		Treatment	14.48
	Post-treatment	Control	15.47
		Ttreatment	12.78

DASH – Disabilities of the Arm, Shoulder, and Hand score

Table 2.2. Between-group and within-group contrasts of CTS6 scores across time points by gender: estimates, *p*-values, and Cohen's *d* effect sizes

Sex	Contrast	Estimate	*p*	*d*
Female				
	Control baseline – treatment baseline	−1.29	0.368	−0.46
	Control baseline – control post-treatment	5.69	**< 0.001**	2.03
	Treatment baseline – treatment post-treatment	7.76	**< 0.001**	2.76
	Control post-treatment – treatment post-treatment	0.78	0.583	0.28
Male				
	Control baseline – treatment baseline	0.12	0.968	0.04
	Control baseline – control post-treatment	4.85	**< 0.001**	1.73
	Treatment baseline – treatment post-treatment	4.38	**0.031**	1.56
	Control post-treatment – treatment post-treatment	−0.36	0.900	−0.13

Table 2.4. Between-group and within-group contrasts of DASH scores across time points by gender: estimates, *p*-values, and Cohen's *d*

Sex	Contrast	Estimate	*p*	*d*
Female				
	Control baseline – treatment baseline	0.72	0.897	0.07
	Control baseline – control post-treatment	5.96	0.083	0.62
	Treatment baseline – treatment post-treatment	13.54	**< 0.001**	1.41
	Control post-treatment – treatment post-treatment	8.30	0.138	0.87
Male				
	control baseline – z-treatment baseline	9.14	0.413	0.95
	control baseline – control post-treatment	8.15	0.061	0.85
	treatment baseline – treatment post-treatment	1.70	0.803	0.18
	control post-treatment – treatment post-treatment	2.69	0.809	0.28

post-treatment. No significant differences were observed between the groups pre- or post-treatment.

The effects of therapy on quality of life

Therapy had an impact on individuals' quality of life. The contrast analysis revealed significant differences between the control group ($p = 0.002$) and the treatment group ($p < 0.001$) for female participants at baseline and post-treatment, with the male control group showing a trend toward significance ($p = 0.080$). A difference between the male treatment and control groups at baseline could be also observed with the treatment group reporting significantly better quality of life ($p = 0.047$) than the control group. No differences between the control and treatment groups were revealed post-treatment.

The effects of therapy on the distal latency of motor fibers

The results showed no significant differences between the treatment and control groups regarding the distal latency of motor fibers at baseline and post-treatment. However, contrast analysis revealed significant differences in distalmotor latency from baseline to post-treatment in both female groups (control: $p = 0.004$; treatment: $p = 0.008$).

Table 2.5. Estimated marginal means (EMMs) of grip strength (kg) by treatment group, time point, and gender

Sex	Time	Group	EMMs of strength, kg
Female			
	Baseline	Control	17.27
		Treatment	20.12
	Post-treatment	Control	19.81
		Treatment	22.75
Male			
	Baseline	Control	35.55
		Treatment	36.23
	Post-treatment	Control	34.68
		Treatment	41.05

EMMs – estimated marginal mean values

Table 2.6. Between-group and within-group contrasts of grip strength (kg) across time points by gender: estimates, *p*-values, and Cohen's *d*

Sex	Contrast	Estimate	*p*	*d*
Female				
	Control baseline – treatment baseline	–2.85	0.153	–0.96
	Control baseline – control post-treatment	–2.53	0.018	–0.86
	Treatment baseline – treatment post-treatment	–2.62	< 0.001	–0.89
	Control post-treatment – treatment post-treatment	–2.94	0.140	–0.99
Male				
	Control baseline – treatment baseline	–0.67	0.866	–0.23
	Control baseline – control post-treatment	0.87	0.513	0.29
	Treatment baseline – treatment post-treatment	–4.83	0.024	–1.63
	Control post-treatment – treatment post-treatment	–6.37	0.112	–2.15

Table 2.7. Estimated marginal means (EMMs) of Visual Analog Scale (VAS) scores by treatment group, time point, and gender

Sex	Time	Group	EMMs of VAS scores
Female			
	Baseline	Control	70.29
		Treatment	69.12
	Post-treatment	Control	75.91
		Treatment	75.15
Male			
	Baseline	Control	72.64
		Treatment	88.20
	Post-treatment	Control	76.64
		Treatment	89.20

EMMs – estimated marginal means, VAS – Visual Analogue Scores

Table 2.8. Between-group and within-group contrasts of Visual Analogue Scale (VAS) scores across time points by gender: estimates, *p*-values, and Cohen's *d*

Sex	Contrast	Estimate	*p*	*d*
Female				
	Control baseline – vtreatment baseline	1.17	0.762	0.23
	Control baseline – control post-treatment	–5.63	0.002	–1.12
	Treatment baseline – treatment post-treatment	–6.03	< 0.001	–1.20
	Control post-treatment – treatment post-treatment	0.77	0.842	0.15
Male				
	Control baseline – treatment baseline	–15.56	0.047	–3.09
	Control baseline – control post-treatment	–4.00	0.080	–0.79
	Treatment baseline – treatment post-treatment	–1.00	0.780	–0.20
	Control post-treatment – treatment post-treatment	–12.56	0.108	–2.50

The effects of therapy on the distal latency of sensory fibers

The results showed no significant differences between the treatment and control groups in terms of the distal latency of sensory fibers at baseline and post-treatment. However, a trend toward significance between the female post-treatment groups could be observed ($p = 0.091$). Contrast analysis revealed a significant difference in sensory distal motor latency from baseline to post-treatment in the female control group ($p = 0.023$), indicating improved nerve function. Notably, the amplitude of sensory and motor evoked nerve potentials did not show significant changes in either sex after therapy or surgery, in any of the groups.

DISCUSSION

The results of this study provide valuable insights into the effectiveness of Maitland's concept of manual therapy compared to open-release surgery for treating CTS. Manual therapy has been found to be as effective as open-release surgery, especially in the case of female patients. This kind of therapy can offer a less invasive alternative for individuals with CTS. Furthermore, it may help establish treatment guidelines for conservative approach and contribute to developing evidence-based practice in managing CTS. The findings suggest that the two interventions can improve certain outcomes, such as grip strength,

Table 2.9. Estimated marginal means of motor fiber distal latency (ms) by treatment group, time point, and gender

Sex	Time	Group	The distal latency of motor fibers (ms)
Female			
	Baseline	Control	5.10
		Treatment	5.31
	Post-treatment	Control	4.46
		Treatment	4.94
Male			
	Baseline	Control	4.74
		Treatment	4.17
	Post-treatment	Control	4.28
		Treatment	4.32

Table 2.10. Between-group and within-group contrasts of motor fiber distal latency (ms) across time points by gender: estimates, *p*-values, and Cohen's *d*

Sex	Contrast	Estimate	*p*	*d*
Female				
	Control baseline – treatment baseline	–0.21	0.598	–0.36
	Control baseline – control post-treatment	0.64	**0.004**	1.07
	Treatment baseline – treatment post-treatment	0.37	**0.008**	0.62
	Control post-treatment – treatment post-treatment	–0.48	0.238	–0.80
Male				
	Control baseline – treatment baseline	0.57	0.486	0.95
	Control baseline – control post-treatment	0.45	0.095	0.76
	Treatment baseline – treatment post-treatment	–0.15	0.728	–0.25
	Control post-treatment – treatment post-treatment	–0.03	0.969	–0.05

Table 2.11. Estimated marginal means of sensory fiber distal latency (ms) by treatment group, time point, and gender

Sex	Time	Group	The distal latency of sensory fibers (ms)
Female			
	Baseline	Control	4.65
		Treatment	4.62
	Post-treatment	Control	4.11
		Treatment	4.71
Male			
	Baseline	Control	4.67
		Treatment	4.89
	Post-treatment	Control	4.43
		Treatment	4.27

Table 2.12. Between-group and within-group contrasts of sensory fiber distal latency (ms) across time points by gender: estimates, *p*-values, and Cohen's *d*

Sex	Contrast	Estimate	*p*	*d*
Female				
	Control baseline – treatment baseline	0.02	0.948	0.04
	Control baseline – control post-treatment	0.54	0.023	0.82
	Treatment baseline – treatment post-treatment	–0.09	0.553	–0.14
	Control post-treatment – treatment post-treatment	–0.60	0.091	–0.92
Male				
	Control baseline – treatment baseline	–0.22	0.753	–0.34
	Control baseline – control post-treatment	0.24	0.415	0.37
	Treatment baseline – treatment post-treatment	0.62	0.186	0.94
	Control post-treatment – treatment post-treatment	0.16	0.828	0.24

symptom severity, and quality of life. However, variations in the effectiveness of these interventions based on gender and specific outcome measures have been found. It should be important for further studies to explore possible mechanisms underlying the differences between the genders.

The study did not incorporate ultrasound as a complementary diagnostic tool alongside ENG. Yet ultrasound plays an important role in the diagnostics of CTS as agreed by experts e.g. in studies such by Pelosi *et al.* [19].

While the present study primarily focused on the comparison of the effectiveness of manual therapy and surgical decompression in the treatment of CTS, it is essential to recognize the importance of accurate diagnosis in applying appropriate treatment strategies. Incorporating ultrasound into the diagnostic process can provide valuable information about median nerve morphology, cross-sectional area, and potential structural abnormalities within the carpal tunnel. Therefore, future research should consider integrating neuromuscular ultrasound into the diagnostic protocol to enhance diagnostic accuracy and inform treatment decisions.

Overall, the research findings indicate that manual therapy and open carpal tunnel release positively affected grip strength, symptom severity, hand function, and quality of life in individuals with CTS [20-22].

The significant increase in grip strength observed in the female and control groups is consistent with previous research demonstrating the positive effects of surgical release [23, 24] and manual therapy treatment [25-27] on hand strength in patients with CTS, however we have found one study that claims that manual therapy has no clinical effect on grip strength [28].The fact that the male treatment group did not show a significantly improved grip strength may be attributed to physiological differences or variations in response to the intervention between genders. However, low representation of men in this study excludes any statistical conclusions on the relationship between sex and grip strength recovery.

The EuroQuol EQ-5D-5L is a reliable tool for assessing the quality of life in patients with CTS [7]. The improvement in quality of life reported by both female groups aligns with a previous study showing the beneficial effects of surgical release on overall well-being and functional abilities [29]. However, the lack of improvement in quality of life in the male groups suggests that additional factors may influence the perceived impact of the interventions on quality of life among men. Further research is needed, as data provided by this study offers insufficient grounds for comparison due to low number of male participants.

The improvement in CTS6 scores, observed in both the treatment and control groups, further support the efficacy of both manual therapy and surgical release in reducing the severity of CTS symptoms [25, 26, 30]. These findings align with previous research that has shown the positive effects of surgical release on symptom relief [30, 31] in addition to the positive impact of manual therapy on symptom relief in patients with CTS [25, 26].

The significant improvement in DASH scores only in the female treatment group suggests that in women manual therapy based on the Maitland concept may have a more targeted effect on functional abilities and daily activities compared to surgical release. This finding highlights the potential benefits of incorporating manual therapy into the treatment plan for patients with CTS. However, in this study, both control groups were on a trend of significance, indicating carpal tunnel release is also a viable option for improving hand function, as demonstrated in previous research [32, 33]. A randomized controlled trial conducted by Wolny *et al.* [34], found that manual therapy, including neurodynamic techniques, resulted in significant improvements in pain intensity, hand function, and nerve conduction studies, compared to a control group that received intervention based on electrophysiological modalities. These findings were supported by a randomized clinical trial by Hamzeh *et al.* [26], in which it was found that manual therapy effectively reduced pain and improved physical function in CTS patients.

The change in distal motor latency in both female groups suggests that both manual therapy and surgical approach had a substantial impact on the electrophysiological properties of the median nerve. Surgery seems to be more effective regarding the improvement of sensory fibers' distal latencies. This finding is consistent with previous research that has shown positive effects of surgical release on nerve distal motor latency [33, 35]. Similarly, a study by Sheereen [25] reported a significant impact of manual therapy on the electrophysiological properties of the median nerve. However, a meta-analysis by Arenas-Arroyo *et al.* [27], did not confirm any significant changes in distal latency or nerve conduction velocity after manual therapy; but Arrenas-Arroyo *et al.* [27], examined short-term treatment-related effects, as opposed to the present study, which had 10-12 month follow-up period. Furthermore, while this study observed improvements in distal motor latency in both treatment and control groups, the findings regarding sensory fibers' distal latency were less conclusive. While there were no significant differences between the treatment and control groups in terms of sensory fibers' distal latency, there was a trend toward significance in the female post-treatment groups. This inconsistency may warrant further investigation into the mechanisms underlying the effects of manual therapy and surgery on sensory nerve function. Moreover, clinicians should include prognostic factors in the decision-making process regarding treatment of patients with CTS. Positive prognostic factors reported by various studies are lower median nerve ultrasonographic cross-sectional area at the pisiform bone, reduced swelling ratio, and lower symptom severity scores [36]. These findings suggest that less pronounced median nerve swelling may indicate a less severe stage of CTS, which is more responsive to treatment. Moreover, short-term benefits observed after manual therapy or surgery were associated with long-term improvements in function [37]. Negative prognostic factors such as symptom duration, positive Phalen's test, and thenar wasting, indicated a significant association with negative outcomes of conservative management [38], so they need to be taken into consideration while making a clinical decision.

It is also worth noting that two of the patients from the treatment group decided to undergo surgery. These patients (one male, one female) had severe symptoms based on CTS6 score, in which both of them scored 26 out of 26 points (mean 9.51 to 12.37). They also displayed limited upper limb functionality according to DASH index, compared to other patients enrolled in this study. They scored 127.5 (female control mean 35.20) points and 74.2 points (male control mean 14.48). These two patients underwent surgery before the final follow-up examination and were not included in the final results. Overall, the results of this study suggest that Maitland's manual therapy effectively improves strength, quality of life, and hand function, and reduces symptom severity in the treatment of CTS. It does have a significant impact on the distal motor latency; however, it does not affect the amplitude of sensory evoked potentials.

These findings support the use of Maitland's manual therapy as an alternative treatment for CTS, potentially avoiding the need for surgical release. Further research is needed to explore the impact of manual therapy treatment on nerves' electrophysiological properties.

CONCLUSIONS

The research presented here provides a comprehensive understanding of the effectiveness of manual therapy and surgical release in treating CTS. The findings suggest that both interventions can improve grip strength and quality of life. However, variations in the effectiveness of these interventions, based on gender and specific outcome measures, can be found. Further research is needed to explore the optimal combination of these interventions for managing CTS.

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Conflict of interest

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