Efficacy of Upper Limb Orthosis in Pregnant Women Presenting with Carpal Tunnel Syndrome

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Abstract

Objective: To find the efficacy of orthosis on the symptoms of CTS in pregnant women and to investigate the impact of use of CTS splint on symptom relief in pregnant women with CTS.

Methods: A randomized controlled trial (RCT) was conducted involving 28 pregnant women diagnosed with CTS. Fourteen participants were assigned to the intervention group, receiving upper limb orthosis for four weeks, while the remaining 14 comprised the control group. Outcome measures were assessed using the Modified Boston Questionnaire (MBQ), focusing on symptoms such as tingling, numbness, discomfort task difficulty and weakness.

Results: Before the intervention, the distribution of patients based on symptom severity according to the Modified Boston Questionnaire (MBQ) showe d that 85.7% experienced numbness or tingling, 71.4% reported pain or discomfort, 78.6% woke up at night due to symptoms, and 100% had difficulty grasping small objects, difficulty with activities, and weakness in hands or fingers. After the intervention, the intervention group demonstrated a significant reduction in MBQ scores (96.5%) and symptoms (92.9%), compared to the control group (3.5% and 7.1%, respectively). The t-test analysis revealed a significant difference ($p < .001$) between the intervention and control groups, indicating the efficacy of upper limb orthosis in pregnant women presenting with CTS.

Conclusion: The study demonstrates the effectiveness of upper limb orthosis in reducing symptoms of carpal tunnel syndrome (CTS) among pregnant women . With a significant reduction in MBQ scores and symptoms severity observed in the intervention group compared to control over a four -week period, early intervention with orthosis proves beneficial. These findings tell the importance of timely diagnosis an d conservative management in alleviating CTS symptoms during pregnancy, potentially minimizing the need for more invasive interventions.

Keywords: Carpal Tunnel Syndrome, Pregnancy, PRCTS, Wrist Splint, Upper limb orthosis, Median Nerve.

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1. Introduction

Carpal tunnel syndrome is a compression neuropathy of median nerve that causes numbness, tingling and pain in the distribution of the median nerve (thumb, index, middle finger, and the radial side of the ring finger.[1-4] It occurs when the median nerve is squeezed or compressed as it travels through the wrist.[2,3] The carpal tunnel is a narrow passageway surrounded by bones and ligaments on the palm side of the hand[1] The carpal tunnel is a nonextendible osteo fibrous tunnel defined as the space located between the flexor retinaculum, which forms the roof, and the carpal sulcus, which forms the base.[6] The anatomy of the wrist, health problems, and repetitive hand motions can contribute to carpal tunnel syndrome.[1,5] A figure of 55–65% of CTS cases are present bilaterally.[1] Pressure on the nerve can happen several ways, including: • Swelling of the lining of the flexor tendons, called tenosynovitis. • Joint dislocations • Fractures • Arthritis • Fluid retention during pregnancy. These conditions can narrow the carpal tunnel or cause swelling in the tunnel. Thyroid conditions, rheumatoid arthritis and diabetes can also be associated with carpal tunnel syndrome. There can be many causes of this condition.[15]

Carpal tunnel syndrome (CTS) is a common problem in pregnancy. Various theories, including morphological factors,[7] hormonal changes[8] and fluid retention,[9,10] have been suggested as contributing factors of CTS in pregnancy. CTS occurs most frequently during the third trimester of pregnancy and a majority of women have symptoms that are severe enough to affect hand function and sleep,[11] indicating that quality of life is significantly affected in these patients. Various factors, such as an increase in body mass index (BMI), hormones, fluid redistribution, and maternal age, are involved in the etiology of PRCTS.[12.13] Symptoms of this condition can include pain, numbness, tingling, occasional clumsiness, tendency to drop things. The numbness or tingling most often takes place in the thumb, index, middle and ring fingers. The symptoms usually are felt during the night but may also be noticed during daily activities such as driving or reading a newspaper. In severe cases, sensation and strength may be permanently lost.

Diagnosis of Carpal Tunnel Syndrome can be obtained by an accurate patient history or by performing physical examination that may include assessing personal characteristics, conducting a sensory examination, performing manual muscle testing of the upper extremity, and utilizing provocative and/or

discriminatory tests (Positive Phalen's test, Durkan's Test, Positive Tinel sign) Obtaining electrodiagnostic tests to differentiate among diagnoses, particularly in cases of thenar atrophy and/or persistent numbness. Electrodiagnostic tests may also be used when clinical and/or provocative tests yield positive results and when considering surgical management.[14] The use of non-invasive diagnostic techniques based on clinical assessments is preferred rather than electromyography, in sensitive populations like pregnant women. The rate of false positivity in electrophysiological tests may be higher than in other diagnostic methods. It may also lead to an increase in the rates of false estimation and then unnecessary treatment.[15]

Better results will occur when carpal tunnel is recognized and treated earlier.[16] The main goal of treatment is to reduce or remove the causes of increased nerve pressure. This should result in a decrease in symptoms. Some nonsurgical treatment options may include 1. Oral anti-inflammatory medicine 2. Steroid injection 3. Wrist splint(s). Oral medications and injections are more effective when symptoms are present for a short period of time, infrequent and mild. Wrist splinting, mainly at night, keeps the wrist out of the bent position. Wrist splints are most helpful with symptoms that are affected by the hand or wrist position. Splints are also more helpful when the symptoms are mild and when symptoms have been present for a shorter period.

Wearing a hand brace helps reduce symptoms and improve functional impairment in individuals with carpal tunnel syndrome (CTS). It provides support to the wrist and limits movement, which can reduce pressure on the median nerve and alleviate symptoms such as pain, numbness, and tingling. Many patients find relief from wearing hand braces, especially at night when symptoms often worsen due to sleeping positions.[17] a splint which supports the wrist and MCP joints is effective[18] Wearing a splint or brace is also recommended as a conservative treatment option for pregnancy-related carpal tunnel syndrome (PRCTS). Correct immobilization can solve up to 80% of symptoms in mild-to-moderate cases of pregnancy-related carpal tunnel syndrome (PRCTS).[19]

A wrist splint serves as a beneficial short-term treatment for Carpal Tunnel Syndrome (CTS). It stabilizes the wrist in a straight or slightly bent-back position, effectively reducing pressure on the median nerve. This allows the wrist a period of "relative rest" from movements that exacerbate CTS symptoms. Nighttime splinting proves effective without the need for medications, making it especially advantageous for pregnant individuals experiencing CTS. Additionally, in the early stages of CTS, nonsurgical methods such as wrist splinting can provide relief and potentially improve the condition, offering a conservative approach to managing symptoms.[20,21]

Fig 1: CTS Wrist Splint

2. Materials & Methods

A Hospital and Clinical based Randomized Controlled Trial was done in Benazir Bhutto Hospital of Rawalpindi Medical University under the institution of Allied Health Sciences. The Study population was all pregnant women presenting with symptoms of CTS. The time duration for this research study was six months after the approval of synopsis. The sample size was: 66 by using Raosoft Sample Size Calculator. A non-probability consecutive sampling technique was applied. A structured questionnaire consisting of the following parts was used. 1- Demographic Details 2- Visual Analogue Pain Scale 3- Modified Boston Questionnaire. Women who were diagnosed with Carpal Tunnel Syndrome (CTS) who meet the inclusion criteria were taken. Informed Consent was taken by explaining the study's purpose, procedures and benefits in a language participants understand (English or Urdu). An informed consent was provided for participants to read and sign, indicating their willingness to participate. If a participant doesn't understand English, the consent form was provided in Urdu along with any necessary explanations. Patients were assured that the confidentiality of their data will not be breached and that it will only be used for the proposed study. Information about participants' demographic characteristics, including age, occupation, medical history, number of children, educational level, age, weight, BMI, marital status, doing exercise was taken.

A non-probability consecutive sampling technique was applied to select participants from all diagnosed individuals. Baseline Assessments were done by doing the Visual Analog Scale (VAS) to assess participants'

pain levels. Calculated the Modified Boston Questionnaire to measure the severity of CTS symptoms and functional limitations. Range of Motion (ROM) tests were conducted to assess joint flexibility and motion. Sensory tests were performed to evaluate nerve function. Motor tests were conducted to assess hand strength and coordination. Randomly assign selected participants to either the intervention group (receiving the CTS splint) or the control group (not receiving the CTS splint). CTS splint to the intervention group was provided and instructed them to use it appropriately. Same assessments were administered (VAS, Modified Boston Questionnaire, ROM tests, sensory tests, motor tests) to both intervention and control groups. Changes in pain levels, CTS symptoms, functional limitations, and physical measurements were recorded for participants using splint.

Data was collected for the control group participants who did not use the splint. The collected data was analyzed using appropriate statistical methods. The outcomes were compared between the intervention and control groups for each assessment tool. The results were interpreted to determine the effectiveness of the CTS splint in reducing symptoms and improving participants' functional abilities. The changes observed in pain levels, symptoms, and physical measurements were interpreted.

Data was entered and analyzed using SPSS version 25.0. Quantitative variables like age, weight and number of children of the patients were represented in Mean ± S.D. Qualitative variables like presence or absence of complications, (Pain, limited mobilization) was represented in Frequencies and percentages. Independent sample t-test is applied to compare quantitative variables between the groups. (to measure functional activity) P-value ≤0.05 was taken as significant association.

3. Results

The study comprised 28 patients with diverse age, parity, education, and demographic backgrounds. Age distribution revealed that 10.7% (n = 3) of the patients were aged 15-20 years, 53.6% (n = 15) were 20-25 years, 25.0% (n = 7) were 25-30 years, and 10.7% (n = 3) were 30-35 years. Parity distribution showed that 32.1% (n = 9) had one parity, 42.9% (n= 12) had two parities, 17.9% (n = 5) had three parities, and 3.6% each had four parities (n = 1) or five or more parities (n = 1). Regarding education, 55.2% (n = 16) had an education level below matriculation, 34.5% (n = 10) had completed matriculation, and 6.9% (n = 2) had an intermediate education level and a bachelor's degree. Demographically, 64.3% (n = 18) of the participants were from urban areas and 35.7% (n = 10) were from rural areas. Additionally, 85.7% (n = 24) of the patients were classified as working women, while 14.3% (n = 4) were housewives.

The study compares the distribution of patients based on symptom severity in both the intervention and control groups before and after a 4-week follow- up period.

Table 1: Showing age distribution

Category	Details with (%)	n
Age Distribution	15-20 years:10.7%	n=3
	20-25years:53.6%	n=15
	25-30 years: 25.0%	n=7
	30-35 years: 10.7%	n=3

Table 2: Showing demographic distribution

Parity Distribution	**One Parity: 32.1%**	**n=9**
	Two Parities: 42.9%	n=12
	Three Parities: 17.9%	n=5
	Four Parities: 3.6%	n=1
	Five or more: 3.6%	n=1
Educational Background	Below Matriculation: 55.2%	n=16
	Matriculation: 34.5%	n=10
	Inter or Bachelors: 6.9%	n=2
Demographic Background	Urban Areas: 64.3%	n=18
	Rural Areas: 35.7%	n=10
Employment Status	Working Women: 85.7%	n=24
	Housewives: 14.3%	n=4

Table 3: The table demonstrates the effectiveness of a treatment for carpal tunnel syndrome (CTS) by comparing outcomes between a control group and intervention group over a 4-week period.

Outcome Measures	Control Group	Intervention Group
Reduction in MBQ score (%)	3.5%	96.5%
Reduction in Symptoms (%0	7.1%	92.9%

In the intervention group, there is a significant reduction in symptom severity after the intervention. Initially, symptoms such as numbness or tingling, pain or discomfort, waking up at night due to numbness, difficulty grasping small objects, difficulty with activities requiring fine finger movements, and weakness in hands or fingers were all scored around 2.5 to 3.0. After the intervention, these scores dropped below 1.5, indicating a marked improvement.

In contrast, the control group showed minimal to no change in symptom severity over the same period. The severity scores for all symptoms in the control group

remained consistently high, around 2.5 to 3.0, with only slight variations. This stark difference highlights the effectiveness of the intervention in reducing the severity of the symptoms.

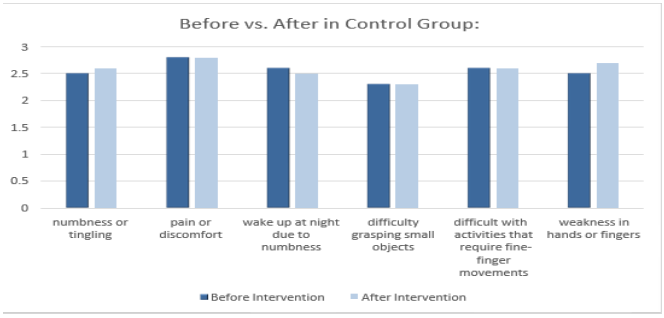

Figure 1: Comparison of Symptoms (before & after) with Control Group

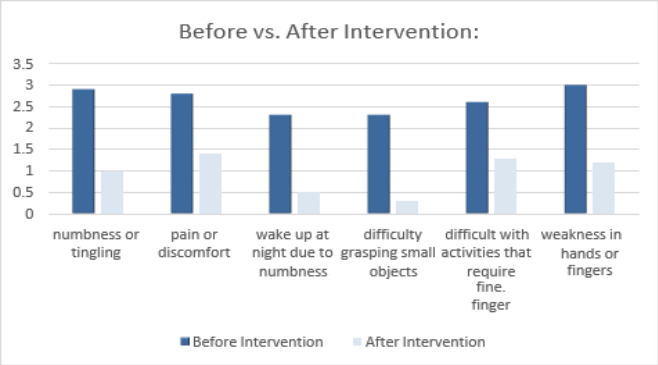

Figure 2: Comparison of Symptoms (before & after) with Intervention Group

Using the Modified Boston Questionnaire (MBQ), which assesses the impact of CTS on daily activities (higher scores indicate more severe symptoms), the control group saw only a 3.5% reduction in scores, indicating minimal improvement. In contrast, the intervention group experienced a significant 96.5% reduction in MBQ scores, reflecting a major improvement in daily function. Similarly, when looking at overall symptom reduction, the control group had a slight 7.1% decrease, showing little change. Meanwhile, the intervention group achieved a substantial 92.9% reduction in symptoms, highlighting the treatment's high effectiveness.

In summary, the intervention led to a pronounced reduction in both MBQ scores and overall symptom severity, highlighting its effectiveness in mitigating the impact of carpal tunnel syndrome on patients' daily lives. The control group, however, showed only minimal improvements, reinforcing the importance and efficacy of the intervention.

For Intervention Group: Sig. (2-tailed): The p-values are both < .001, indicating highly significant results.

For Control Group: Sig. (2-tailed): The p-values are 0.291 and 0.310, both greater than the typical significance level of 0.05, indicating that the results are not statistically significant.

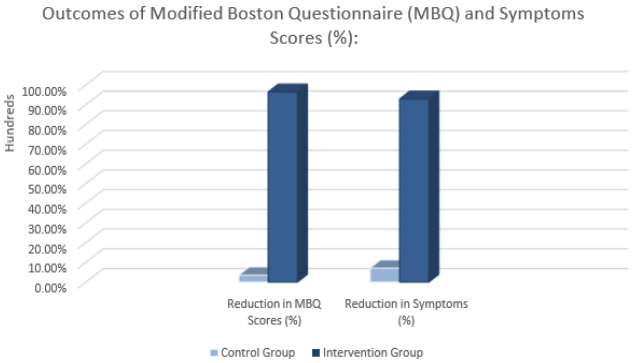

Figure 3: Comparison of Outcomes of MBQ score among Control & Intervention Group

Explanation: The t-tests compare the change in symptom severity scores before and after the intervention between the intervention group and control group. For the intervention group, the highly negative t-values and very low p-values indicate a significant reduction in symptom severity after the intervention. The mean differences are substantial (around -13.89), and the confidence intervals confirm these changes are statistically significant.

In contrast, the control group shows t-values close to zero and p-values above 0.05, indicating no significant change in symptom severity over the same period. Overall, these results demonstrate that the intervention had a significant effect in reducing symptom severity compared to the control group, where symptoms remained largely unchanged.

4. Discussion

The findings of this study shed light on the efficacy of upper limb orthosis as a conservative treatment for carpal tunnel syndrome (CTS) in pregnant women. The significant reduction in Modified Boston Questionnaire (MBQ) scores and symptom severity observed in the intervention group compared to controls suggests that orthosis intervention plays a beneficial role in alleviating CTS-related symptoms during pregnancy. These results are consistent with previous literature highlighting the importance of orthosis in reducing wrist discomfort, numbness, tingling, and functional limitations associated with CTS. The observed improvement in symptom severity in the intervention

group underscores the importance of early diagnosis and proactive management strategies in pregnant women presenting with CTS symptoms. By providing mechanical support to the wrist and maintaining a neutral wrist position, orthosis may help alleviate pressure on the median nerve, reduce inflammation, and improve nerve function, thereby relieving CTS symptoms. Moreover, the non- invasive nature and ease of application of orthosis make it a practical and accessible treatment option for pregnant women, particularly those seeking conservative management approaches.

The findings of this study align with previous research on CTS during pregnancy, such as the work conducted by Aslihan Alp Ozturk (2022) in Turkey. Ozturk's study emphasized the significance of early diagnosis and management of PRCTS using non- invasive diagnostic tools and conservative treatments. [(22)] Teemu Karjalanen's (2022) research on the efficacy of conservative treatments for CTS highlighted the effectiveness of wrist splinting, particularly during nighttime, in reducing symptoms and improving functional outcomes of patients. [(23)]

These findings support the use of wrist splinting as a cost-effective and non-invasive intervention for managing CTS symptoms, as also suggested in the study on splinting for CTS conducted in Australia (2012).

5. Conclusion

The use of upper limb orthosis is an effective conservative treatment for managing carpal tunnel syndrome (CTS) symptoms in pregnant women. The significant reduction in Modified Boston Questionnaire (MBQ) scores and symptom severity in the intervention group compared to control group highlights the importance of orthosis in alleviating CTS-related discomfort and functional limitations during pregnancy. These findings underscore the importance of early intervention and proactive management strategies to improve patient outcomes and quality of life. However, further research is warranted to validate these results in larger cohorts and explore optimal orthosis designs and treatment protocols. Overall, orthosis presents a promising option for the management of CTS in pregnant women, offering a non- invasive, cost-effective approach to symptom relief and improved maternal well-being.

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