Journal of Pain & Relief
ISSN: 2167-0846
Gene et al., J Pain Relief 2024, 13:11
Research Article
Open Access

Retrospective Clinical Analysis on Treatment Outcomes of Nocturnal Splinting vs Platelet-Rich Plasma for Select Severities of Carpal Tunnel Syndrome

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Abstract

Carpal Tunnel Syndrome (CTS) is a prevalent peripheral neuropathy characterized by wrist discomfort, weakness, and numbness. Repetitive hand motions and underlying medical conditions that impair nerve function are among the etiology. Platelet-Rich Plasma (PRP) injections have shown promise in relieving functional abilities and symptoms, but there are still discrepancies in their effectiveness across the varying CTS severities. This retrospective single-centre study aims to compare the efficacy of the PRP injections against conservative nocturnal splinting, specifically in hopes of preventing or delaying the need for Open Carpal Tunnel Release Surgery (OCTR) and improving symptom severity across each CTS severity (mild, moderate, and severe). With the help of Electromyography (EMG) readings, patients diagnosed with CTS were categorized into mild, moderate and severe and then further subdivided into the treatment they received: nocturnal splinting or PRP. A Boston Carpal Tunnel Questionnaire (BCTQ) was used to assess patient symptom severity and functional status, and patient charts were read to confirm those who underwent the OCTR surgeries. According to BCTQs, PRP did not differ from the conservative treatment cohort in improving symptom severity and well-being in either of the severity groups. Lower rates of OCTR surgery were observed in the PRP severe groups in comparison to nocturnal splinting; however, mild and moderate PRP severity groups had increased rates of OCTR when compared to conservative nocturnal splinting. These findings, however, are not statistically significant ($p > 0.05$). Clinicians should consider CTS severities when selecting treatment options as well as acknowledge the limitations and statistical significance of this retrospective study. Further randomized controlled studies with larger cohort sizes are needed to confirm these findings

Keywords: Carpal tunnel syndrome; Platelet-rich plasma; Nocturnal splinting; Open carpal tunnel release; Electromyography; Boston carpal tunnel questionnaire

Introduction

Affecting 3% of the general population, Carpal Tunnel Syndrome (CTS) is one of the most common peripheral neuropathies [1,2]. Due to the compression of the median nerve within the carpal tunnel, patients exhibit symptoms such as numbness, pain, tingling, and weakness in both the hand and wrist [3,4]. The etiology of CTS is multifactorial and can include genetic predispositions, repetitive hand movements, rheumatoid arthritis, pregnancy, and systemic conditions such as Diabetes Mellitus [5]. The optimal management of CTS remains a subject of debate. While conservative treatments such as nocturnal wrist splinting, activity modification, and corticosteroid injections are the first-line therapies for mild to moderate cases, they may not be generalizable or consistent in eliminating symptoms [6]. Open Carpal Tunnel Release (OCTR) is often a treatment for severe cases when conservative treatment options do not improve the patient's symptoms. However, the procedure can pose risks of infection, scar sensitivity, and prolonged recovery times and it often takes months to see a specialist.

Nocturnal splinting is a well-studied, non-invasive treatment for mild to moderate cases of CTS. Patients will typically splint the wrist during the night to maintain a neutral position of the wrist that prevents it from bending and flexing, as these motions will compress the median nerve and increase the pressure within the Capral tunnel. Wrist movements during the night are typically what worsens the compression of the nerve. This treatment is considered standard for mild to moderate cases, as splinting can reduce pressure and compression through stabilization, thus alleviating symptoms of tingling, numbness and pain. Most importantly, it is also a low-cost and non-invasive intervention for patients [6].

Platelet-Rich Plasma (PRP) injections, on the other hand, are a form of semi-permanent interventional pain management that is considered safer for more severe cases of CTS with a minimal recovery period [7,8]. PRP is made up of the patient's platelets, which contain various growth factors needed to promote nerve regeneration and reduce inflammation in the area [9,10]. Some studies have reported that PRP injections can alleviate symptoms and improve overall nerve function. Despite the literature present to prove its efficacy, it is minimal. These studies have methodological flaws, a lack of follow-up periods with patients, and, most importantly, a failure to consider the discrepancies between severities of CTS [11].

This retrospective study reviews the outcomes of conservative nocturnal splinting and PRP injections in considering the varying severities of CTS. It will assess if PRP can prevent or delay the need for OCTR and improve symptom severity and functional status using Boston Carpal Tunnel Questionnaires (BCTQs). Our group

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Received: 01-Nov-2024; Manuscript No: jpar-24-151826; **Editor assigned:** 04-Nov-2024, PreQC No: jpar-24-151826(PQ); **Reviewed:** 18-Nov-2024; QC No: jpar-24-151826; **Revised:** 22-Nov-2024, Manuscript No: jpar-24-151826(R); **Published:** 29-Nov-2024, DOI: 10.4172/2167-0846.1000681

Citation: Gene JJ, Desai J, Jadawala M (2024) Retrospective Clinical Analysis on Treatment Outcomes of Nocturnal Splinting vs Platelet-Rich Plasma for Select Severities of Carpal Tunnel Syndrome. J Pain Relief 13: 681.

hypothesizes that individuals who use PRP as a treatment option will postpone or prevent OCTR in comparison to conservative nocturnal splinting, and PRP will have a more beneficial impact on symptom severity than nocturnal splinting.

Methods

An EMR (Electronic Medical Records) System software Accuro, was used to select the CTS patients. The eligible candidates that were selected through Accuro were based on predetermined criteria of carrying the condition of CTS and undergoing either of the two treatment procedures outlined in this study. The detailed inclusion and exclusion criteria are listed below. To minimize selection bias and enhance the representativeness of the sample, the selection approximated a random sampling start point within the constraints of this retrospective data analysis, as every 3rd patient that met the eligible criteria from the database was selected for the study. The search resulted in 84 nerves that met the selected inclusion criteria listed below. In cases in which individuals had bilateral CTS, each wrist was considered independently, and statistical analyses accounted for any intra-patient correlations.

EMG and nerve conduction studies were performed according to standardized protocols and the CTS severities were classified as below [12] (Supplementary Table 1 and Supplementary Table 2).

Treatment interventions

Conservative Nocturnal splinting treatment protocols were as follows; wearing the wrist splint to maintain the wrist in a neutral position to prevent movement and thus eliminate irritation and pain. Patients wore the splints at night as this is the time in which symptoms are most prominent. As per previous literature, splints were worn for roughly 8 weeks and during the day if symptoms persisted [12]. PRP injection treatments were prepared using about 20mL of the patient's blood and centrifuged to extract the PRP layer with the necessary platelet growth factors. With the help of ultrasound guidance, a single PRP injection was administered into the nearby area of the carpal tunnel of the affected wrist.

Data collection

The BCTQ surveys were administered via telephone, with each question read aloud by the researcher. There were 11 questions to determine the symptom severity scale and 8 questions to determine the functional status of the patients. Each question was scaled 1-5, and a total score for each section was tabulated. Patients were informed that the questionnaire was part of a routine clinical follow-up, and their results may also be used for research purposes. Consent was obtained. BCTQ is a validated, patient-reported questionnaire which correlates higher scores with worse symptoms or a greater functional impairment [12,13].

Statistical analysis

BCTQs were expressed as mean ± Standard Deviation (SD) and categorical variables of OCTR rates were expressed as frequencies and percentages assessed by the Shapiro-Wilk test. Comparisons between treatment groups were performed using independent Samples t-test, Chi-square test as well as Generalized Estimating Equations (GEE) to account for intra-patient correlations in bilateral cases. A p-value < 0.05 was considered statistically significant and Bonferroni correction was applied for the multiple comparisons between cohort severities and treatments. Additionally, a COREQ Consolidated criteria for reporting qualitative research Checklist was completed to ensure full transparency and standardization for this retrospective analysis.

Results

OCTR rates

In comparing both treatment groups of the nerves that had PRP and conservative nocturnal splinting, the rates of those who required OCTR are found in Table 1. The mild CTS/PRP treatment cohort (n=19) required OCTR in 2 cases (10.5%), while none of the nerves in the mild/conservative treatment cohort (n=12) (0%) required the OCTR p=0.51. For the moderate CTS/PRP treatment group (n=20), 13 of those nerves required OCTR (65%) compared to 9 out of (n=19) (47.4%) in the conservative cohort required OCTR (p=0.30). In the severe CTS group, the PRP treatment cohort (n=6) required OCTR in 4 cases. (66.67%), while the conservative cohort required surgery in 7 out of (n=8) patients (87.5 %) p=0.58. None of the comparisons reached statistical significance, indicating no substantial differences in the rates of OCTR between the treatment options across the severity levels.

BCTQ

Mean symptom severity and functional status scores were obtained using the BCTQ and are also found in Table 1. For patients with mild CTS, the conservative treatment cohort (n=3) had a mean Symptom Severity Score (SSS) of (28.67 ± 12.66) and a Functional Status Scale (FSS) score of (21.67 ± 8.50). The mild PRP cohort (n=4), however, exhibited a slightly lower mean score of (26.00 ± 6.67) and lower FSS (8.50 ± 6.60). The p-values for SSS and FSS comparisons were 0.82 and 0.18, respectively, indicating no statistically significant differences. The moderate conservative cohort (n= 5) had a mean SSS of (29.67 ± 12.63) and a FSS mean of (15.33 ± 6.67). The moderate PRP cohort (n=15) had a mean SSS of (31.89 ± 6.75) and FSS (19.78 ± 8.00) scores,

Table 1: Comparison of OCTR Surgery Rates and BCTQ Scores by CTS Severity and Treatment Groups.

CTS Severity	Treatment Group	Number of Nerves (n)	OCTR Required (n, %)	SSS Mean ± SD	FSS Mean ± SD	p-value (OCTR)	p-value (SSS)	p-value (FSS)
MILD	PRP	19	2, 10.50%	26 ± 6.67	8.5 ± 6.6	0.51	0.82	0.18
	Conservative	12	0, 0%	28.67 ± 12.66	21.67 ± 8.5			
Moderate	PRP	20	13, 65%	31.89 ± 6.75	19.78 ± 8	0.3	0.71	0.87
	Conservative	19	9, 47.40%	29.67 ± 12.63	15.33 ±6.67			
Severe	PRP	6	4, 66.67%	26.5 ± 5.5	22.5 ± 10.5	0.58	N/A	N/A
	Conservative	8	7, 87.50%	29 ± N/A	35 ± N/A			

NOTE: OCTR= Open Carpal Tunnel Release Surgery; CTS=Carpal Tunnel Syndrome; PRP=Platelet Rich Plasma.
OCTR Required: Number and percentage of nerves that required Open Carpal Tunnel Release surgery within each group. SSS: Symptom Severity Score from the Boston Carpal Tunnel Questionnaire (BCTQ). FSS: Functional Status Score from the BCTQ.
p-values: ** Statistical significance of differences between PRP and Conservative groups within each CTS severity category for OCTR rates, SSS, and FSS.
NA indicates not applicable due to insufficient data. N/A (Not Available) Standard deviation is not available for groups with n=1.

with p-values of 0.71 for SSS and 0.87 for FSS, again demonstrating no significant differences. For severe CTS, only one conservative patient was evaluated, with a mean SSS of 29.00 and FSS of 35.00. The severe PRP cohort (n=2) reported mean scores of 26.50 ± 5.50 for SSS and 22.50 ± 10.50 for FSS; however, statistical analysis was not applicable (NA) due to the low sample size.

While OCTR rates focused on each nerve independently to assess the localized surgical outcomes, the BCTQ was utilized to evaluate patient well-being on a broader scope that encompasses an overall score of well-being by averaging both nerves functional and symptomatically. As the BCTQ is a well-being assessment designed to reflect overall hand function and quality of life, the goal is to capture the patient's general improvement in daily activities rather than isolating each nerve's contribution to functional outcomes. The results suggest that there is no statistically significant difference between PRP and conservative nocturnal splinting treatment approaches in preventing OCTR or demonstrating symptom severity and functional status improvements across the varying severity levels of CTS.

Discussion

This retrospective study aimed to evaluate the effectiveness of PRP injections compared to conservative nocturnal splinting in patients with mild, moderate, and severe CTS. Our findings indicate that PRP may pose a potential treatment option for CTS concerning pain management but did not demonstrate a statistically significant advantage over the conservative treatment of nocturnal splinting in delaying Open Carpal Tunnel Release (OCTR) or in improving symptom severity and functional status as per the BCTQs. Our results, however, may not align with previous studies in proving that PRP can enhance nerve regeneration and reduce inflammation, leading to total symptom relief [14-16]. Within each severity group, there was no indication of statistically significant differences among the treatment options. The PRP cohort in the severe CTS groups did exhibit a lower percentage of patients who required OCTR, but the results were not statistically significant. In the mild and moderate PRP subgroups, there were slight increases in rates of OCTR in comparison to conservative treatments. This should raise further questions regarding the clinical benefits of PRP regarding specific subgroups of disease severity. Our results do, however, coincide with some literature that PRP may not necessarily impact symptom relief despite our work in segregating patients into different severity groups [17,18]. As nocturnal splinting is known to be a widely accepted treatment for mild to moderate CTS, these findings may support the continued use of the procedure for patients in the mild to moderate categories [19,20].

It is crucial to account for the several limitations presented in this study, including the extremely small sample sizes of this study, which will impact the generalizability of these results. Additionally, using a retrospective design may introduce areas of selection bias and confounding variables that were not controlled for. In treating each nerve independently in bilateral cases, we understand the possible infringement on the assumption of independent observations despite our efforts to minimize bias and control for these variables using GEE in our statistical analysis. Future research should include larger sample sizes, randomized controlled trials, as well as longer follow-up periods. Standardization of PRP preparation and administration protocols is also essential to improve the reproducibility and comparability of our results.

Conclusion

PRP treatment may offer similar symptom relief to conservative management of nocturnal splinting despite the categorization of CTS severities. A decrease in OCTR rates for nerves diagnosed with severe CTS in comparison to conservative treatment options, and a higher proportion of patients requiring OCTR in the mild and moderate groups may raise questions about treatment efficacy and limitations. Clinicians should begin to consider the classifications of severity of CTS when selecting treatment options and remain cautious due to the limitations of current evidence. With the lack of statistical significance and small sample size used in our study, future extensive research using high-quality studies with larger sample sizes on these matters is needed to establish the role of PRP in CTS management.

Acknowledgments

We thank the staff at the MINDS Neurology Clinic for their support in data collection.

Funding

No external funding was received for this study. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon request.

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