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Safety and effectiveness of ultrasound-guided single injection of 5% dextrose for median nerve hydrodissection in carpal tunnel syndrome

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ABSTRACT

Background: In carpal tunnel syndrome (CTS), conservative management did not show satisfactory results, and some patients required revision surgery due to persistent or recurrent symptoms. Ultrasound (USG)-guided median nerve (MN) hydrodissection with a 5% dextrose injection is an advanced approach for treating symptoms of CTS. We prospectively investigated the patients to demonstrate the safety and effectiveness of this approach. **Aims and Objectives:** This study aims to evaluate the effect of USG-guided nerve hydrodissection using single injection of 5% dextrose on pain, MN conduction parameters, and functional status in patients with CTS of mild–to-moderate grade. The study also predicts about the safety of the procedure. **Materials and Methods:** A study was performed in the pain clinic of the tertiary care teaching institute of India for one year. The study included 15 patients diagnosed with mild-to-moderate CTS. The diagnosis was done on the basis of history, physical examination, and a nerve conduction velocity (NCV) study. Patients were given analgesics and NSAIDS and enrolled in the procedure. Parameters used for statistical analysis were Visual Analog Scale (VAS) scores, NCV study data (sensory conduction velocity [SNCV] and distal motor latency [DML]), and Boston carpal tunnel questionnaire (BCTQ) scores. Pre-injection parameters were compared with parameters 3 months after the injection to show the usefulness of this procedure. **Results:** A statistically significant reduction in VAS score was found in 74% of the cases ($P<0.05$). The nerve conduction study parameters have shown significantly higher SNCV and lower DML latency in 60% of cases ($P=0.001$ and $P=0.001$, respectively). Improved BCTQ scores were found in 80% of cases (for the symptom severity scale, $P=0.001$ and for the functional status scale, $P<0.01$). No complications such as allergic reactions, sensory loss, or paresis were recorded post-injection. However, transient injection site pain was present in all patients which did not last for more than 24 h. **Conclusion:** MN hydrodissection using a single injection of 5% dextrose under USG is a safe and effective approach offering pain relief, better MN conduction, and improved functional status in patients with CTS of mild-to-moderate grade.

Key words: Hydrodissection; 5% dextrose; Carpal tunnel syndrome; Median nerve neuropathy

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INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common type of peripheral entrapment neuropathy, with a worldwide incidence of 3–4%.[1] It affects the age group of 40–60 years, mostly females. Increased pressure inside the carpal tunnel leads to compression of the median nerve (MN), which produces the signs and symptoms of CTS.[2,3] The patient presents with wrist pain, sensory (numbness, paraesthesia, tingling of lateral 3½ fingers), and motor (weakness and

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atrophy of the thenar muscle) symptoms.[4] Conservative treatment (analgesics, NSAIDS, physiotherapy, splints) has limited effect in relieving the symptoms. CTS of moderate-to-severe grade requires surgery; however, there is a risk of persistence or recurrence in 3–20% of cases.[5] In those cases, the pain of CTS remains a frustrating clinical scenario. Hence, a novel approach is required that is safe and provides symptomatic management for CTS. Ultrasound (USG)-guided nerve hydrodissection is a great example. In previous studies, a comparison of various agents such as normal saline, local anesthetics, corticosteroids, hyaluronidase, 5% dextrose in water, and platelet-rich plasma (PRP)[6-10] was done for their efficacy in hydrodissection of nerves. However, there is still debate on deciding the single best agent. Various researches are being done regarding application of 5% dextrose hydrodissection in cases of peripheral nerve entrapments in recent years. In those studies, repeated injections of 5% dextrose for hydrodissection were given to relieve the symptoms of nerve entrapments, but data regarding the effect of a single injection on the patient's clinical profile are lacking. The purpose of our study is to elucidate the effectiveness and safety of a single injection of 5% dextrose under USG for hydrodissection of MN in mild-to-moderate grade CTS. Direct visualization of the nerve under USG during perineural injection avoids nerve injury and related complications.[11-13]

The grading of CTS was done as (I) mild: abnormal sensory conduction velocity (SNCV) with a normal distal motor latency (DML); (II) moderate: an abnormal SNCV and DML; or (II) severe: the absence of sensory responses and abnormal DML.[14] In the nerve conduction velocity (NCV) study, median SNCV <50 m/s and median DML >4.2 ms are considered abnormal values.[15] The Boston Carpal Tunnel Questionnaire (BCTQ) includes two subscales: symptom severity scale (SSS) and the functional status scale (FSS). There are 11 questions on SSS and 8 questions on FSS, with scores ranging from 1 to 5 for each question. The visual Analog Scale (VAS) is a 10-point scale where "0" indicates no pain and "10" indicates the worst pain. Response to therapy was assessed using changes in the VAS[16] score, NCV parameters, and BCTQ score.

Aims and objectives

This study aims to evaluate the effect of ultrasound guided nerve hydro dissection using single injection of 5% dextrose on pain, median nerve conduction parameters and functional status in patients with carpal tunnel syndrome of mild to moderate grade. The study also predicts about the safety of the procedure.

MATERIALS AND METHODS

The study was an observational study conducted in a tertiary care institute over a period of 1 year from May 2022 to April 2023 after getting permission from the institutional ethical committee. Written informed consent was taken from each patient before the procedure.

Inclusion criteria included were females and males of age >20 years to <60 years, single or B/L CTS (in the case of B/L CTS, the side with more severe symptoms was included in the study; however, treatment was provided for both sides), CTS of any duration, and CTS non-responsive to the conservative treatment. Exclusion criteria included patients with severe CTS (distal latency to abductor policies breves muscle >6.5 ms or with absent motor or sensory potentials of the MN by NCV study), previous h/o perineural injection or surgery for CTS, pregnancy, patients with a history of allergy to bee or wasp venom or concurrent use of antihistaminic, cortisone, or salicylates, polyneuropathy, brachial plexopathy, or thoracic outlet syndrome, systemic infection, CTS due to systemic causes (thyroid disease, diabetes mellitus, or acromegaly), or other conditions, for example, rheumatoid arthritis, osteoarthritis, gout, or psoriatic arthritis.

All the patients who attended the pain clinic during the study period and fulfilled the inclusion and exclusion criteria were selected for the study. We included 15 such patients with mild-to-moderate grade CTS. Among them, 10 were females and 5 were males. None of them had any other significant comorbidity. In pre-procedure visit, VAS scores, BCTQ scores, and SNCV and DML of MN were recorded. Patients were prescribed analgesics. Blood tests for CBC, BT, CT, PT, and INR were done to rule out any infection, bleeding disorder, etc. On the day of the procedure, after taking proper consent, an intravenous cannula was inserted to inject 1 g of ceftriaxone. A linear array transducer (10–18 MHZ) was placed on the wrist in a dorsiflexed position to locate the short-axis view of MN. The needle entry point is infiltrated with 1 mL of 1% lignocaine. A 25-G, 2-inch needle attached to a 5 mL syringe was inserted by in-plane technique and ulnar approach at the proximal inlet of the carpal tunnel (scaphoid pisiform level), and 5 mL of 5% dextrose was injected to dissect the nerve from the subsynovial connective tissue. Next, 5 mL of 5% dextrose was injected by an in-plane approach just above the MN to separate it from the flexor retinaculum. Hydrodissection made the MN free from the fascia throughout the canal. The endpoint of hydrodissection was confirmed by visualization of anechoic injectate above and below the MN and a rounded/oval appearance of the MN instead of an elliptical appearance. After the completion of the procedure, patients were asked to

visit the outpatient department after 3 months for an assessment. In the follow-up visit, VAS scores and BCTQ scores were recorded, and the NCV study was done.

Outcome measures

The primary outcome was measured as improvement in VAS scores. Outcomes were categorized as (a) effective outcome (decrease in VAS score ≥50% compared to pre-procedural value) and (b) ineffective outcome (decrease in VAS score <50% compared to pre-procedural value).[17]

The secondary outcome measured was improvement in NCV parameters and BCTQ scores. In the NCV study, an increase in sensory NCV and a decrease in DML compared to baseline were considered as effective outcomes. Opposite changes in these values or no change at all was the evidence of a poor outcome. A decrease in BCTQ score compared to baseline was considered as effective outcome.[18]

Statistical analysis

Relevant data were compiled and entered into a spreadsheet in MS Excel 2016 MSO (version 2402). Statistical analysis was done using a paired t-test with an 80% power of study and a 5% probability of type 1 error. P<0.05 was considered as statistically significant. Pie charts were used to represent the outcomes.

RESULTS

Table 1 shows the pre-procedure VAS score of patients to be 6.73±0.7 (mean±SD). In the follow-up visit after 3 months, this value was reduced to 3.2±2.3. Figure 1 demonstrates an effective decrease in VAS score in 74% of patients while 26% of patients presented with an unsatisfactory outcome. The overall decrease in VAS score was statistically significant (P<0.05).

According to the data in Table 1, the pre-procedure values of SNCV and DML were 39.43±2.44 and 5.74±0.43, respectively. After the procedure, SNCV increased to 45.74±6.85 (P=0.001) and DML decreased to 4.92±0.98 (P=0.001). Figure 2 illustrates an improvement in NCV parameters in 60% of cases, and 20% of cases had not shown improvement compared to baseline.

The data in Table 1 show baseline scores for SSS and FSS to be 29.93±5.96 and 20.13±5.23, respectively. After 3 months, SSS was 19.86±8.53 (P=0.001) and FSS was 13.06±7.83 (P<0.01). Figure 3 shows marked improvement in BCTQ scores in 80% of cases, while in 20% of cases, results were not satisfactory.

Post-procedure analysis has shown that 74% of the patients got satisfactory pain relief, i.e., a statistically significant reduction in the NRS score was observed (P<0.05). 60% of the patients had shown significant changes in NCV values (P=0.001). Furthermore, improvement in the BCTQ score was found in 80% of cases (P<0.01).

DISCUSSION

Similar to our study Wu et al.,[19] in year 2017 in their trial discussed the 6-month efficacy of using 5% dextrose for USG-guided perineural injection in mild-to-moderate CTS. However, they used 5 mL of 5% dextrose. In our study, we used 10 mL of 5% dextrose.[20] Unlike our study, they used normal saline for perineural injection in the control group. However, they got better results with 5% dextrose.

Li et al.,[14] in year 2021 in a retrospective study described the safety and long-term outcome of 5% dextrose hydrodissection in CTS. In our study, short-term follow-up was done. Unlike our study, they mentioned multiple times 5% dextrose injection in patients. However, our study aims to assess the effect of single-time nerve hydrodissection. 88.6% of patients had shown effective outcomes, whereas in our study, effective results for pain, NCV parameters, and BCTQ were 74%, 60%, and 80%, respectively.

He et al.,[21] in year 2022 in a retrospective study calculated a VAS score of 3.6±1.4 (P< 0.001) at the end of 12 weeks in the group (steroid) that received perineural injection with steroid whereas VAS was 2.3±1.4 in the group receiving 5% dextrose as add-on therapy 4 weeks after steroid injection

Table 1: Comparison and analysis of pre- and post-procedure parameters

Parameters	Before procedure Mean value (SD)	3 months after procedure Mean value (SD)	P-value
VAS	6.73 (0.7)	3.2 (2.3)	<0.05
SNCV (m/s)	39.43 (2.44)	45.74 (6.85)	0.001
DML (ms)	5.74 (0.43)	4.92 (0.98)	0.001
BCTQ (SSS)	29.93 (5.96)	19.86 (8.53)	0.001
BCTQ (FSS)	20.13 (5.23)	13.06 (7.83)	<0.01

VAS: Visual Analog Scale, SNCV: Sensory conduction velocity, DML: Distal motor latency, BCTQ: Boston carpal tunnel questionnaire, SSS: Symptom severity scale, FSS: Functional status scale

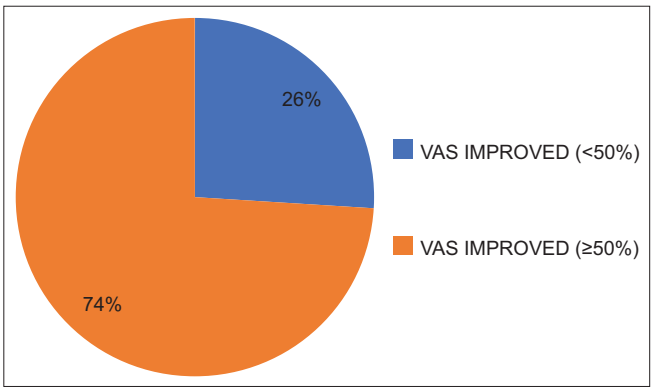

Figure 1: Improvement in Visual Analog Scale scores

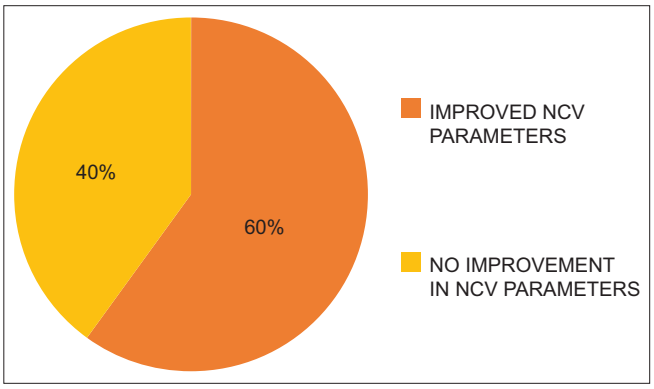

Figure 2: Improvement in nerve conduction velocity parameters

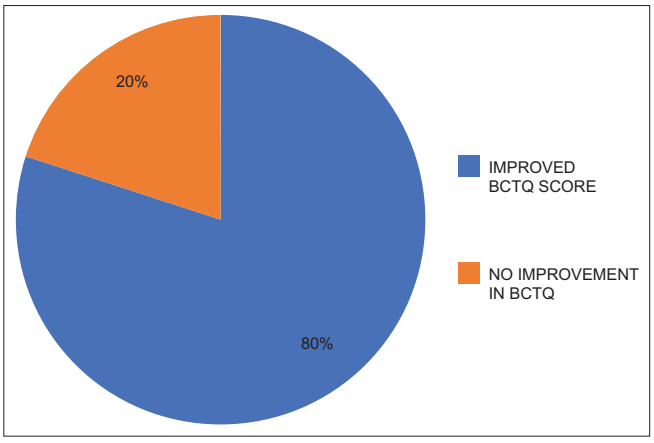

Figure 3: Improvement in Boston carpal tunnel questionnaire scores

(combined). Similarly, in our study, the VAS score was 3.8±2.5 3 months after 5% dextrose hydrodissection of the nerve; however, steroids were not used in these patients. The baseline VAS score in our study was 10, whereas it was 6.1±1.6 and 6.3±1.6 in the steroid group and combined group, respectively. After 3 months of procedure, we recorded a reduction in BCTQ SSS from 29.93±5.96 to 19.86±8.53 (P=0.0008) and a decrease in BCTQ FSS from 20.13±5.23 to 13.06±7.83 (P<0.007) in both cases. He et al., in their study, showed a reduction in BCTQ SSS from 28.7±5.2 to 19.0±3.5 (P<0.001) in the steroid group and from 29.3±4.9 to 14.8±2.8 (P<0.001) in the combined group, and a reduction in BCTQ FSS from 19.3±3.5 to 12.6±2.3 (P<0.001) in the steroid group and from 18.6±4.1 to 11.4±2.2 (P<0.001) in the combined group. Hence, they emphasized the use of 5% dextrose as an add-on therapy with corticosteroids.

Wu et al.,22 in 2016, used extracorporeal shock wave therapy in CTS. In the follow-up visit after 12 weeks, they found a decrease in VAS from 6.36±0.87 to 2.70±1.23 (P<0.001), BCTQ SSS from 32.65±7.86 to 18.45±4.76, and BCTQ FSS from 17.70±4.21 to 10.60±2.28 (P<0.001) in the intervention group. The trial showed an increase in SNCV (m/s) from 31.81±5.33 to 34.92±6.14 (P<0.001) whereas our study revealed an increase in SNCV (m/s) from 39.43 (2.44) to 45.74 (6.85). Trends in this study correlate with data of our study.

Gao et al.,[23] in year 2023, in a network meta-analysis of a randomized control trial compared the effectiveness of 5% dextrose with PRP and corticosteroids. They reported that after 5% dextrose injection surface, under cumulative ranking curve was 74.4%, 72.2%, and 72.1% for symptom relief, improved function, and pain relief, respectively. However, we found functional improvement in 80% of cases and pain alleviation in 74% of cases.

Wu et al.,[24] in year 2018, did a comparative study of triamcinolone and 5% dextrose for perineural injection and demonstrated better results with 5% dextrose after 4–6 months of follow-up (P<0.01).

Wu et al.,[25] in year 2021, did a narrative review to describe the mechanism of action of 5% dextrose. It has a mechanical effect that helps to separate compressed nerves during hydrodissection. It has a pharmacological effect that helps to stabilize neural activity, decrease neurogenic inflammation, downregulate capsaicin-sensitive receptors (TRPV1), hyperpolarization of C fibers, and stop the transmission of noxious stimuli. It also has a neuroregenerative effect.

Buntragulpoontawee et al.,[6] in year 2021, in a systematic review, described that USG-guided perineural injections are safe. Only one case reported a local steroid injection-related complication. Similarly, in our study, no major adverse reaction was found post-procedure except transient injection site pain, which resolved within 24 h.

Chao et al.,[1] in year 2022, in a retrospective study, demonstrated results of 5% dextrose hydrodissection in patients with persistent and recurrent CTS. 61.1% of patients presented with satisfactory effects after a mean of 3.3 injections and a follow-up of 33 months. However,

our study excluded patients with history of carpal tunnel surgery, and we focused on a single injection of 5% dextrose with short-term follow-up.

Limitations of the study

A small sample size was the major limitation of our study. We have conducted short-term follow-up with the patient, so recurrence of the disease in the long-term cannot be ruled out. We included patients with CTS of long duration as well as newly diagnosed patients. It might have created bias while assessing the patient's response.

CONCLUSION

A single injection of 5% dextrose for nerve hydrodissection is a very safe and effective approach for treating the pain and other symptoms of CTS of mild-to-moderate grade.

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Authors' Contribution:
NJ- Literature survey, preparation of manuscript, implementation of study protocol, data collection, clinical protocol, review manuscript, submission of article;
CKJ - Statistical analysis, editing, literature survey and preparation of figures, coordination and manuscript revision.

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