Scholars LITERATURE

La Prensa Medica Argentina

Research Article

DOI: https://doi.org/10.47275/0032-745X-328
Volume 107 Issue 3

Ultrasound-Guided Hydrodissection for Treatment of Patients with Carpal Tunnel Syndrome

Mohammad Asi Jabbar[1]*, Mohammed Sadeq Ibrahim[1] and Mortada Abd Al-Hussian Jubara[2]

[1]Department of Anasthesia, Al-Shaheed Ghazi Al-Harriri Hospital, Baghdad Medical City, Ministry of Health and Environment, Baghdad, Iraq
[2]Department of Anasthesia, House Nursing Private Hospital, Baghdad Medical City, Ministry of Health and Environment, Baghdad, Iraq

Abstract

The study aimed to compare Ultrasound-Guided Normal saline plus steroid hydrodissection group and Ultrasound-Guided normal saline alone hydrodissection group in patients with carpal tunnel syndrome (CTS), and to determine their clinical relevance in relation to treatment outcomes. We performed 60 US-guided hydrodissections Normal saline with and without corticosteroid injections in 51 patients with CTS, and evaluated their pre- and post-injection US findings. We categorized these injections into two groups based on the normal saline plus corticosteroid (steroid group). normal saline (control group) and we also recorded clinical data including gender, age, side of injection, BW, and the duration of pre-injection CTS related discomfort. The outcomes were measured using the visual analog scale was assigned to assess the primary outcome. The secondary outcomes were assessed using the Boston Carpal Tunnel Syndrome Questionnaire, cross-sectional area of the median nerve, and electrophysiological studies. The assessment was performed prior to injection, and 1, 3, and 6 months' post-injection, and the symptom relief for the patients receiving normal saline and steroid injection were compared. We compared hydrodissections with normal saline and corticosteroid injections. The clinical data, pre injection CSA-MN at the inlet of the carpal tunnel, and pre-injection BCTQ scores showed no significant intergroup differences ($p > 0.05$). All patients (data from 30 wrists in each group) completed the study. Compared both the control group, at all post-injection time points, both groups had a significant reduction in pain and disability, improvement on electrophysiological response measures, and decreased cross-sectional area of the median nerve. Our study reveals that ultrasound-guided Normal saline with and without corticosteroid hydrodissection has therapeutic effect in patients CTS. Nerve hydrodissection was shown to be potentially beneficial for CTS patients pre-surgery. Hydrodissection is a simple, minimally invasive procedure that can be performed using only NS. In addition, compared to blind injection, hydrodissection under ultrasound guidance can lower the chances of nerve injury.

Keywords: Carpal Tunnel Syndrome; Hydrodissection; Corticosteroid; Normal Saline Injection; Ultrasound Guidance

Correspondence to: Mohammad Asi Jabbar, Department of Anasthesia, Al-Shaheed Ghazi Al-Harriri Hospital, Baghdad Medical City, Ministry of Health and Environment, Baghdad, Iraq; Tel: 7733962400; E-mail: Medicalresearch68@yahoo.com

Citation: Jabbar MA, Ibrahim MS, Al-Hussian Jubara MA (2021) Ultrasound-Guided Hydrodissection for Treatment of Patients with Carpal Tunnel Syndrome. Prensa Med Argent, Volume 107:3. 328. DOI: https://doi.org/10.47275/0032-745X-328

Received: March 03, 2021; **Accepted:** April 12, 2021; **Published:** April 17, 2021

Introduction

Carpal tunnel syndrome (CTS), involving compression of the median nerve (MN) deep to the flexor retinaculum, is one of the most common nerve entrapment syndromes encountered in musculoskeletal practice [1,2]. The age distribution is bimodal with first peak in early 50s and second peak at age 75-84 years, and women, especially during pregnancy, are more commonly affected than men [3]. There are many causes and risk factors for carpal tunnel syndrome, such as trauma, vascular lesions, inflammation, obesity, occupational exposure, older age, osteoarthritis, pregnancy, hypothyroidism, or autoimmune diseases [4-8].

Pathophysiology of CTS is due to multifactorial causes, including nerve compression and traction disorders of the intraneural microcirculation, direct lesioning of the myelin sheath and axon, and alteration in the supporting connective tissue. Increased carpal tunnel pressure is thought to cause ischemic compression of the median nerve [9]. The severity of carpal tunnel syndrome can be divided into 5 levels, from very mild symptoms (pins and needles sensation, pain, or sensibility loss in the fingers and/ or hand, mostly only during nighttime) to continuously very severe symptoms (pins and needles sensation, pain, significant then atrophy, and/or significant sensibility loss in the fingers and/or hand, most time) [10].

Although ultrasound of the carpal tunnel can depict similar MRI criteria used in CTS, the most commonly evaluated parameter has been the median nerve cross-sectional area. Using the circumferential trace mode on the ultrasound screen, the cross-sectional area of the median nerve can be measured. A widely accepted cutoff cross-sectional surface area for CTS with the highest sensitivity and specificity is 10 mm^2, measured at the carpal tunnel inlet or pisiform. This sensitivity and specificity are high [11-14]. Although to avoid blind injection complications and for providing safer, reliable, and more efficient needle tip placement during CTS injections, ultrasound (US) guidance can play a beneficial role. Currently, musculoskeletal US has gained popularity based on its dynamic real-time property and low-cost availability [15]. Ultrasound provides high-resolution scanning view of median nerve and surrounding vessels and tendons and assists in diagnosis as well as needle placement guidance. Hence, there is a

need for new intervention during the pre-surgical stages of CTS. Hydrodissection is a minimally invasive procedure of injecting fluid into anatomic spaces to facilitate dissection and adhesiolysis during surgery. injecting the material between the MN and transverse carpal ligament and underlying tendons which may interrupt the adhesions of MN and reduce the symptoms [16,17].

Materials and Methods

Study Design

This prospective, randomized, controlled, double-blind study was conducted between January 2017 and July 2018. In Nursing home in Baghdad Medical City and Private Pain Management Clinic. A total of 51 patients of them (total 60 wrists) were enrolled. Patients with suspected diagnosis of CTS were referred for this trial by orthopedic, neurologist and neurosurgery specialists. We obtained clinical history, and performed physical examinations and electrophysiological studies. All patients signed informed consent and were block-randomized in a 1:1 ratio by drew random numbers from a sealed envelope. The patients were assigned to either a steroid group or a control group.

In the steroid group (n=30), patients underwent one session of ultrasound-guided median nerve hydrodissection with 1cc Triamcinolone 40 mg mixed with 5 cc normal saline (NS) total volume 6 cc. Patients in the control group (n=30) received ultrasound-guided guided median nerve hydrodissection with 6 cc normal saline (NS). If the patients were diagnosed as bilateral CTS, both wrists were assigned to the same group.

Any other conservative management regarding CTS therapy was prohibited from 2 weeks prior to initiation until 6 months post injection except for acetaminophen (500 mg, up to 2g per day), which was allowed for pain relief.

Inclusion and Exclusion Criteria

Patients, aged 20-80 years, diagnosed with mild-to-moderate CTS, with symptoms lasting for a minimum of 6 months, and confirmed by electrophysiological study, were enrolled. The definition of clinical symptoms/signs, and inclusion and exclusion criteria are presented in table 1 and table 2 [18].

The methods used for diagnosing and grading CTS based on electrophysiological study are presented in table 3 and table 4 [17-19].

Table 1: Inclusion criteria of symptoms and signs (Diagnosed as CTS if meeting criterion 1 with more than one of criteria 2 or 3 or 4).

Nocturnal paresthesia/dysthesia with or without pain over the subjected hand, which could be associated with posture or overuse of the wrist ; or relieved with shaking motion of the hand.
Numbness in the sensory distribution of MN.
Weakness with atrophic change of the MN-innervated thenar muscles.
Phalen's test (+) and/or Tinel's sign (+)

Table 2: Exclusion criteria (met anyone).

History of polyneuropathy, brachial plexopathy, thoracic outlet syndrome or wrist surgery
History of inflammatory arthritis, hypothyroidism, diabetes mellitus , pregnancy, and rheumatologic disorders or having pacemarker.
Current warfarin use, previous steroid injection for CTS, trauma or neoplasm at injection site, hypersensitivity to corticosteroid, skin infection (injection site).

Table 3: Electrophysiological Study Cut-off points or abnormal value.

1.Distal sensory latency of MN > 3.6ms (Stimulator: 14 cm distant from the active electrode at 2nd interphalangeal joints).
2.DML of the MN ≥ 4.3 ms (Stimulator: 8 cm distant from the active electrode at thenar muscle).

Table 4: Electrophysiological Study Grades.

1.Minimal: abnormal segmental or comparative tests only
2.Mild: only abnormal digit/wrist SNCV+ normal DML.
3.Moderate: abnormal digit/wrist SNCV+ abnormal DML
4.Severe: absent digit/wrist SNCV+ abnormal DML.
5.Extreme: both absent motor and sensory responses.

The US-guided injection technique was performed using the ulnar side approach. The patients were maintained a comfortable seated position with hands placed on a pillow, the forearm supinated and the wrist resting in a neutral position. In-plane ulnar approach was used for the US-guided CTS hydrodissection technique. Intervention was performed with a commercially available sonographic scanner (ALpinion, the E-CUBE i7 with 10 to 12-MHz linear transducer).

The transducer was placed transversely along the distal wrist crease (transversely between the pisiform and the scaphoid bone) and perpendicular to the median nerve at carpal tunnel inlet (Figure 1). The flexor retinaculum was visualized as the hyperechoic structure forming the carpal tunnel roof across the pisiform and scaphoid bones. The median nerve lies just below the flexor retinaculum, the ulnar nerve and artery were detected just radial to the pisiform outside the carpal tunnel. Doppler imaging can be used to confirm the artery location if necessary. The injection was performed under sterile conditions with an in-plane freehand technique. After skin preparation with an antiseptic chlorhexidine 2%, the proximal carpal tunnel was visualized

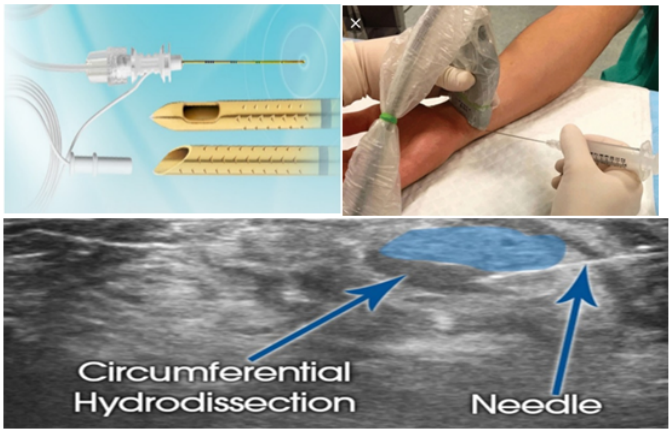

Figure 1: Sterile US transducer cover and pajunk echogenic 50 mm 22G Needle was used.

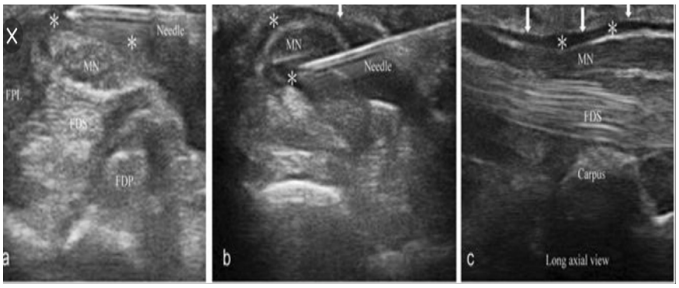

Figure 2: Hydrodissection the MN from the flexor retinaculum and hydro-dissected the inferior MN away from the flexor tendons.

with the same transducer. A sterile US transducer cover and pajunk echogenic 50 mm 22G Needle was used. Needle entrance anesthetized with 1 cc xylocaine 1% then inserted into the skin from the ulnar side of the proximal carpal tunnel at the level of the distal wrist crease. The needle passed to skin nearly parallel with the transducer. It traverses superficially to the ulnar nerve and artery, penetrating the flexor retinaculum. Under real-time ultrasound-guide median nerve hydro dissection with 1cc Triamcinolone 40 mg mixed with 5 cc normal saline (NS) total volume 6 cc or 6cc NS. 3 cc inject was injected to hydro-dissected the MN from the flexor retinaculum, and the residual 3 cc inject was then injected to hydro-dissected the inferior MN away from flexor tendons (Figure 2).

After injection, the operator scanned through the whole carpal tunnel to confirm the delivery of inject throughout the tunnel hydrodissection the MN from the flexor retinaculum and hydro-dissected the inferior MN away from the flexor tendons.

Every patient was observed for half an hour after injection for any complications, such as nerve trauma, ecchymosis or bleeding etc., before discharge.

Outcome Measurements

We performed all outcome assessments, without knowledge of which group patients were in or the injectate content, at 1, 3, and 6 months post-injection, for comparison with pre-injection measures Outcome Measurements.

Primary Outcome

Visual analog scale (VAS): The severity of digital pain or paresthesia or dysesthesia within one week before evaluation was recorded using VAS, with the score ranging from 10 (tremendous pain) to 0 (no pain) [20]. A minimum decrease of 1.3 points in VAS or 25% reduction in pain is considered the minimal clinically important difference for pain intensity

Secondary outcome: Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) Score. The self-administered BCTQ includes 2 subscales of symptom severity (11 questions) and functional status (8 questions); it is the most commonly used measurement for CTS. Scores range from 0 to 5 points for each question, with higher scores indicating greater severity and dysfunction.

Secondary Outcome

Cross-sectional Area (CSA) of the MN: Circumferential trace mode on the ultrasound screen, the cross-sectional area of the median nerve can be measured. In brief, the CSA was measured using an electronic caliper at the proximal inlet of the carpal tunnel (i.e., at the scaphoid-pisiform level). The mean of 3 such measurements was used for analysis.

Electrophysiological analysis results: The anti-dromic sensory nerve conduction velocity (SNCV) and distal motor latency (DML) of the MN were measured in all patients as described elsewhere. In brief, the SNCV was measured using a 14-cm stimulator that was proximal to the active electrode over the second inter-phalangeal joint. The DML was recorded via MN stimulation at 8 cm proximal to the active electrode over the abductor pollicis brevis muscle. An average of 3 such measurements was calculated.

Statistical Analyses

All data were analyzed using IBM SPSS software, version 22. Demographic data were analyzed using an independent t-test for continuous data, and Fisher exact test for categorical data. A repeated-measures analysis of variance and a subsequent post hoc test was used for analysis of the follow up data. An independent t-test was performed to compare differences between groups, including VAS scores, BCTQ scores, CSA of MN measurements, electrophysiological study results, and global assessment results. All statistical tests were 2-tailed; a P value of less than 0.05 was consider statistically significant.

Results

During an 18-month period (January 2017 and July 2018), 79 carpal tunnel injections were undertaken in 70 patients with CTS. 19 patients were excluded because loss of follow-up US examinations (19 injections in 19 patients). In total, we included 60, injections that were performed in 51 patients (Figure 3). Clinical characteristics of the participants did not differ between groups (Table 5). All results showed in table 6-table 10. The mean duration of symptom onset was 31.54±6.54 and 32.73±5.73 months in the normal saline plus Steroid hydrodissection Group and normal saline alone hydrodissection Group, respectively.

Both groups exhibited a significant reduction in pain and disability became more pronounced as the follow-up duration increased revealed significant improvement for VAS in both group data were analyzed using an Independent t test, Chi-square test or Fishers exact test.

Both groups exhibited a significant reduction in Boston Carpal Tunnel Syndrome Questionnaire score for severity and function became more pronounced as the follow-up duration increased revealed significant improvement.

Found that both groups had significant electrophysiologic

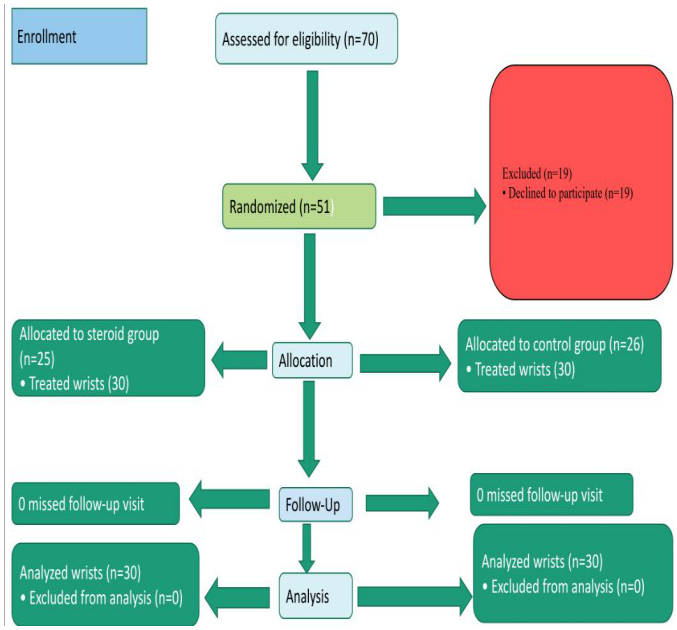

Figure 3: Study flow diagram.

Table 5: Baseline demographic and clinical characteristics of study participants.

Characteristic	Normal saline plus Steroid hydodissection Group N(30 wrist)	Normal saline hydrodissection Group N(30wrist)	P value
Age (y)	52.74±3.23	52.53±2.56	<0.90
Body height (cm)	157.16±2.25	156.14±1.32	<0.73
Body weight (kg)	68.21±1.7	69.12±1.2	<0.70
Duration (months)	31.54±6.54	32.73±5.73	<0.99
Gender N Male Female	 2 28	 1 29	<0.83
Lesion sits Right Left	 18 12	 16 14	<0.97
Grading Mild Moderate	 15 15	 13 17	<0.89
BCTQS Severity functional	29.25±1.53 21.56±0.65	28.52±2.03 19.28±0.43	<0.45 <0.26
VAS	6.891±0.41	6.45±0.36	<0.99
CSA(mm²)	12.54±0.45	12.63±0.36	<0.51

BCTQ=Boston Carpal Tunnel Syndrome Questionnaire severity and function. Data was analyzed using an Independent t test, Chi-square test or Fishers exact test.

improvement immediately after hydrodissection, showed improvement in nerve conduction values as the follow-up duration increased.

We checked complication after injection, including nerve insult, vessel insult, and skin lesion (eg, color change). Infection in both groups: 2 patients in Normal saline plus Steroid hydodissection Group. N (30 wrist) had vascular insult that resolve after two days of procedure. 5 patients in Normal saline plus Steroid hydodissection Group. N (30 wrist) had ecchymosis that resolved after one week of procedure compare with 3 patients in control group.

Table 6: The Visual analog scale score.

Visual analog scale score	Normal saline plus Steroid hydodissection Group N(30 wrist)	P value	Normal saline hydrodissection Group N(30wrist)	P value
Before injection	6.89±0.41		6.45±0.36	
Month 1	4.73±0.37	<0.001	5.42±0.21	<0.001
Month 3	3.29±0.35	<0.001	3.69±0.51	<0.001
Month 6	2.89±0.21	<0.001	2.59±0.37	<0.001

Table 7: Boston Carpal Tunnel Syndrome Questionnaire score.

Boston Carpal Tunnel Syndrome Questionnaire score	Normal saline plus Steroid hydodissection Group N(30 wrist)	P value	Normal saline hydrodissection Group N(30wrist)	P value
severity	Mean ± standard error		Mean ± standard error	
Before injection	29.25±1.53		28.52±2.03	
Month 1	20.68±1.05	<0.001	24.20±1.03	<0.001
Month 3	16.20±1.46	<0.001	17.20±2.63	<0.001
Month 6	14.16±0.87	<0.001	15.20±1.82	<0.001
Functional	Mean ± standard error		Mean ± standard error	
Before injection	21.56±0.65	<0.001	19.24±0.43	
Month 1	13.20±1.43	<0.001	16.20±1.09	<0.001
Month 3	12.20±1.03	<0.001	14.20±1.54	<0.001
Month 6	11.20±1.65		12.20±1.85	<0.001

Table 8: Electrophysiological study.

Electrophysiological study	Normal saline plus Steroid hydodissection Group N(30 wrist)	P value	Normal saline hydrodissection Group N(30wrist)	P value
Sensory nerve conduction velocity (m/s)	Mean ± standard error		Mean ± standard error	
Before injection	33.56±1.03		33.79±0.83	
Month 1	35.68±1.05	0.04	34.20±1.03	0.99
Month 3	36.20±1.03	0.003	36.70±1.13	0.003
Month 6	36.16±1.17	0.004	36.14±1.82	0.004
Distal motor latency (ms)	Mean ± standard error		Mean ± standard error	
Before injection	4.86±0.63		4.68.±0.16	
Month 1	4.72±0.21	0.22	4..70±0.15	0.51
Month 3	4.64.±0.22	0.53	4.72±0.15	0.32
Month 6	4.53.±0.26	0.20	4.5±0.17	0.43

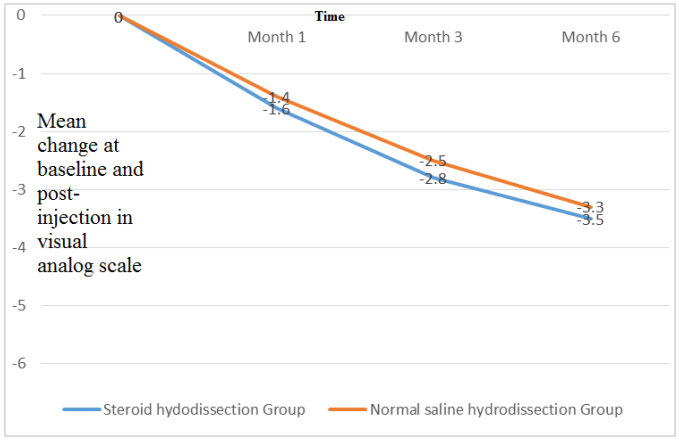

Figure 4: Mean change at baseline and post-injection in visual analog scale results in both groups (mean standard error). The visual analog scale scores were significantly lower in the both groups, at all follow-up assessments (P<0.05), and this reduction became more pronounced as the follow-up duration increased an independent t-test was used.

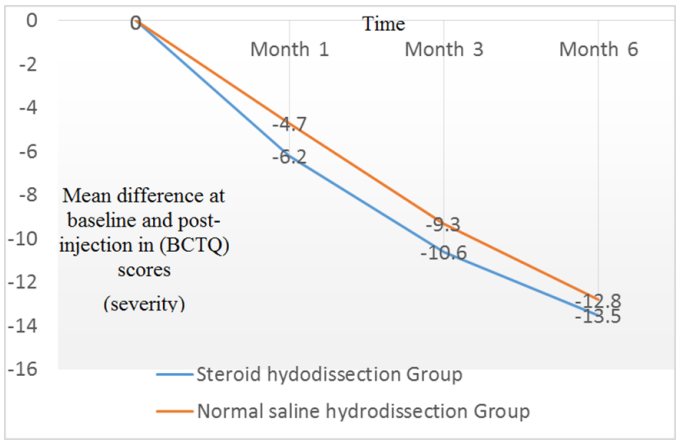

Figure 5: Mean difference at baseline and post-hydrodissection in Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) scores(severity) in both groups (A) The BCTQ scores were significantly lower, indicating improvement at all follow-up assessments (P<0.05).

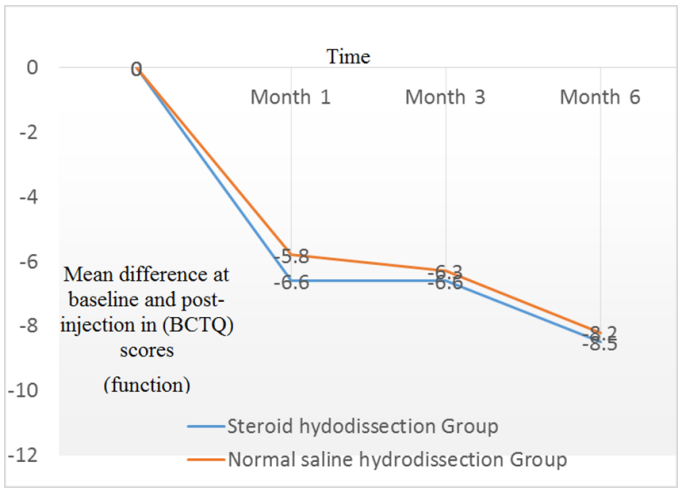

Figure 6: The BCTQ (function) scores were significantly lower, indicating improvement, in both groups, at all follow-up assessments (P<0.05). All differences became more pronounced as the follow-up duration increased.

Table 9: Complications.

Complications	Normal saline plus Steroid hydodissection Group N(30 wrist)	Normal saline hydrodissection Group N(30wrist)
nerve insult N	0	0
vessel insult N	2	0
lesion (eg, color change) N	5	3
Infection N	0	0

Discussion

The present study is prospective, randomized, controlled study to compare the benefit of Ultrasound-Guided Normal saline plus steroid hydro dissection group and Ultrasound-Guided normal saline alone hydro dissection group in patients with carpal tunnel syndrome (CTS) both groups exhibited a significant reduction in pain and disability, an improved electrophysiological response, and a decreased CSA of the MN for 6 months after treatment.

Our technique provided direct visual guidance under US, as well as actual separation of the MN from the compressing flexor retinaculum throughout the carpal tunnel by hydrodissection

Evers et al demonstrate that, in a cadaver preparation, infiltration of saline into the carpal tunnel can reduce the resistance to longitudinal sliding of the median nerve This experiment was prompted by recent interest in the concept of 'hydrodissection' for the treatment of carpal tunnel syndrome [21]. This can be traced back to a 2008 Smith J et al paper describing an ultrasound guided approach to the familiar procedure of corticosteroid injection for CTS in which the needle is inserted from the ulnar border of the wrist, transversely into the carpal tunnel [22], The authors speculated that the infiltration of inject between the median nerve and transverse carpal ligament, and between the median nerve and underlying tendons "may disrupt adhesions". Since then enthusiasts for ultrasound guided carpal tunnel injection have adopted the idea that they are breaking adhesions between the nerve and surrounding structures as an established fact. The term 'hydrodissection' has become common place in descriptions of ultrasound guided carpal tunnel injections, and the technique has even been described in a recent textbook as being useful for disrupting adhesions, especially after surgery [23].

The first thing which is notable about all of the above-mentioned papers is that in every case the hydrodissection procedure is carried out with an inject containing between 40 and 80 mg of methylprednisolone, or an equivalent amount of an alternative steroid. Corticosteroid injection is known to be markedly effective in the short term as a treatment for CTS, with approximately 80% of patients reporting benefit from injection, even when the injection is not ultrasound guided and no attempt is made at hydrodissection [24-26]. It should therefore procedure confers additional benefit over and above corticosteroid injection without hydrodissection, or alternatively that hydrodissection alone, with saline, has a therapeutic effect superior to that of a placebo injection, in which saline would be injected just proximal to the carpal tunnel with the same ultrasound guidance.

Injection-related placebo effects and spontaneous remission of CTS could contribute to the therapeutic effects in our study. Unfortunately, the individual contribution of the placebo effect vs. nerve hydrodissection is hard to differentiate as the minimal volume

of inject that is necessary for a significant effect of nerve dissection is unknown. Wu YT, et al. (2017) [27], found that ultrasound-guided perineural injection with 5 cc NS could improve symptoms 6 months' post injection in patients diagnosed with mild-to-moderate CTS compared with their baseline.

Marshall SC, et al. (2002) [24], also reported that 33% of patients showed clinical improvement 12 weeks post ultrasound-guided perineural injection of 2 cc NS. Nevertheless, the injection-related placebo effect was stronger than the placebo effect after a non-interventional procedure. Kirwan J, et al. (2001) [28], have shown almost 30% pain reduction from placebo effect within the first few weeks after intra-articular injection for patients with knee osteoarthritis. A recent meta-analysis, however, demonstrated statistically and clinically significant improvement 6 months post intra-articular injection of NS for knee osteoarthritis [29].

Additionally, the possibility of spontaneous remission in these prior studies cannot be completely excluded. Padua L, et al. (2001) [30], revealed that patients with untreated CTS showed between 27% and 34% symptomatic improvement after 10 to 15 months' follow-up in a prospective study.

Ortiz-Corredor F, et al. (2008) [31], demonstrated that 25% and 47.6% of untreated patients with CTS showed electrophysiological improvements and symptom recovery respectively in a 2-year follow-up study. Because we used a uniform injection procedure and injectate volume in a randomized, double-blind, controlled trial, the possible concurrent effect of placebo effect and spontaneous remission cannot ignore in our study.

In our study, we found that the majority of parameters of BCTQ improved in both groups at the initial follow-up time point. As the effect of nerve hydrodissection is postulated to be initiated at early follow-up time points, this result was unexpected. The injection-related placebo effect may influence the initial therapeutic effect in both groups making it hard to distinguish the intergroup differences until progressive nerve regeneration which often occurs at later stages after hydrodissection. Peripheral nerve regeneration is a relatively slow process, proceeding at a rate of 1 mm/day in humans. One study showed re-innervation of the thenar eminence by the median nerve after carpal tunnel release (CTR) of at least 12 months [32]. In a cohort study of 45 patients with mild, moderate, and severe CTS, individuals were treated with CTR and a postoperative electrophysiologic evaluation was performed 2 weeks, 2 months, and 6 months after surgical decompression. The authors found that the mild group had significant electrophysiologic improvement immediately after decompression. The moderate group showed marked improvement in nerve conduction values in all cases. In the severe group, electrophysiologic improvement was seen, but normalization of electrophysiologic test values were only possible in a few patients [33]. Extrapolating from this study, it would be safe to assume 6 months to be adequate for repeat electrodiagnostic testing.

We think that the effect of hydrodissection-induced mechanical remobilization of the MN may be brief because NS does not have any additional pharmacological effect. We hypothesized that the initial therapeutic effect may result from the mechanical hydrodissection and that subsequent nerve regeneration would contribute to the observed long-term effect. In contrast to BCTQ, CSA is an objective measure that would be unaffected by injection-related placebo effect. We observed significant decreased CSA between the two groups from 1-month post injection through all follow-up time points. These findings may indicate that the effect of nerve hydrodissection can be observed as early as 1-month post injection. However, Peters-Veluthamaningal C, et al. (2010) [26], found that 5 of 33 (15%) patients exhibited a satisfactory partial response at a follow-up assessment at 1 week after a 1-cc normal saline injection. Girlanda P, et al. (1993) [34], reported notable improvement in nocturnal paresthesia and motor action potential at up to 2 months after a 15-mg normal saline injection (9 mg/cc; 2 injection sessions with a 1-week intervening interval).

The effect of normal saline injection in our study was longer and more pronounced, compared with the effects in the aforementioned research, possibly owing to differences in the guided method or inject volume. Our study was the first to use ultrasound guided injection with normal saline for the control group, and the 6 cc of inject was a greater volume than that used in previous studies. A direct compression of the transverse carpal ligament at the MN induces CTS, and CTS subsequently induces inflammation of the intra-carpal tendon. This condition commonly causes a cycle of swelling within the carpal tunnel and further compresses the MN [35]. Moreover, compared with blind injection, ultrasound- guided nerve hydrodissection is better for removing surrounding tissues from the MN, especially the intra-carpal tendons.

Limitations

Our study has some limitations. First, the small patient group with female predominance and the lack of long-term follow-up.

Second, we were not able to determine the influence or most appropriate timing of nerve hydrodissection. the recurrence rates and long-term effects of treatment are unknown. Further research should include longer study periods to determine nerve hydro dissection has therapeutic effect in patients with mild-to-moderate CTS, additional benefit for the long-term CTS treatment and to verify the effects of reducing recurrence.

Finally, the optimal dosage and number of hydrodissection. sessions are unknown, so further studies are needed

Conclusion

This study demonstrates that nerve hydro dissection has therapeutic effect in patients with mild-to-moderate CTS. Nerve hydrodissection was shown to be potentially beneficial for CTS patients pre-surgery. Hydrodissection is a simple, minimally invasive procedure that can be performed using only NS. In addition, compared to blind injection, hydrodissection under ultrasound guidance can lower the chances of nerve injury. Moreover, the cumulative effect of hydrodissection is expected after repeated injections, and hydrodissection may also have possible advantages for post-operative adhesion in patients with CTS.

Recommendation

In future research, nerve hydrodissection could be compared with traditional management techniques, e.g. splint, physical therapy and its effect could be studied in CTS patients with post-operative adhesions or unsuccessful surgery. Further studies are also needed to prove the effect of this technique for other entrapment neuropathies.

Abbreviations and Acronyms

BCTQ= Boston Carpal Tunnel Syndrome Questionnaire;

CSA= cross-sectional area;

CTS= carpal tunnel syndrome;

DML= distal motor latency;

MN = median nerve;

SNCV= sensory nerve conduction velocity;

VAS= visual analog scale,

MN= median nerve;

SNCV= digit/wrist sensory nerve conduction velocity;

DML= distal motor latency

Informed Consent

It was obtained to publishing this case.

Declaration of Competing Interest

None.

Funding Information

None.

Acknowledgments

None.

References

1. Stevens JC, Sun S, Beard CM, O'fallon WM, Kurland LT (1988) Carpal tunnel syndrome in Rochester, Minnesota, 1961 to 1980. Neurology 38: 134-138. https://doi.org/10.1212/WNL.38.1.134
2. Katz JN, Simmons BP (2002) Carpal tunnel syndrome. N Engl J Med 346: 1807-1812. https://doi.org/10.1056/NEJMcp013018
3. Tanaka S, Wild DK, Seligman PJ, Behrens V, Cameron L, et al. (1994) The US prevalence of self-reported carpal tunnel syndrome: 1988 National Health Interview Survey data. Am J Public Health 84: 1846-1848. https://doi.org/10.2105/AJPH.84.11.1846
4. Harris-Adamson C, Eisen EA, Dale AM, Evanoff B, Hegmann KT, et al. (2013) Personal and workplace psychosocial risk factors for carpal tunnel syndrome: a pooled study cohort. Occup Environ Med 70: 529-537. http://dx.doi.org/10.1136/oemed-2013-101365
5. Aroori S, Spence RA (2008) Carpal tunnel syndrome. Ulster Med J 77: 6-17.
6. Bland JD, Rudolfer SM (2003) Clinical surveillance of carpal tunnel syndrome in two areas of the United Kingdom, 1991-2001. J Neurol Neurosurg Psychiatry 74: 1674-1679. http://dx.doi.org/10.1136/jnnp.74.12.1674
7. Palmer KT, Harris EC, Coggon D (2007) Carpal tunnel syndrome and its relation to occupation: a systematic literature review. Occup Med 57: 57-66. https://doi.org/10.1093/occmed/kql125
8. Viera AJ (2003) Management of carpal tunnel syndrome. Am Fam Physician 68: 265-272.
9. Aboonq MS (2015) Pathophysiology of carpal tunnel syndrome. Neurosciences (Riyadh) 20: 4-9.
10. Verhagen AP, De Vet HC, De Bie RA, Kessels AG, Boers M, et al. (1998) The Delphi list: a criteria list for quality assessment of randomized clinical trials for conducting systematic reviews developed by Delphi consensus. J Clin Epidemiol 51: 1235-1241. https://doi.org/10.1016/S0895-4356(98)00131-0
11. Jacobson JA (2017) Fundamentals of musculoskeletal ultrasound. (1st edtn.), Saunders, Philadelphia, United States.
12. Wong SM, Griffith JF, Hui AC, Lo SK, Fu M, et al. (2004) Carpal tunnel syndrome: diagnostic usefulness of sonography. Radiology 232: 93-99. https://doi.org/10.1148/radiol.2321030071
13. Fowler JR, Gaughan JP, Ilyas AM (2011) The sensitivity and specificity of ultrasound for the diagnosis of carpal tunnel syndrome: a meta-analysis. Clin Orthop Relat Res 469: 1089-1094. https://doi.org/10.1007/s11999-010-1637-5
14. Sernik RA, Abicalaf CA, Pimentel BF, Braga-Baiak A, Braga L, et al. (2008) Ultrasound features of carpal tunnel syndrome: a prospective case-control study. Skelet Radiol 37: 49-53. https://doi.org/10.1007/s00256-007-0372-9
15. Babaei-Ghazani A, Eftekhar-Sadat B, Ghabili K (2015) Simultaneous bilateral biceps tendon rupture: a case report with practical sonographic diagnosis. Am J Phys Med Rehabil 94: e13-e18. https://doi.org/10.1097/PHM.0000000000000169
16. Lee SJ, Choyke LT, Locklin JK, Wood BJ (2006) Use of hydrodissection to prevent nerve and muscular damage during radiofrequency ablation of kidney tumors. J Vasc Interv Radiol 17: 1967-1969. https://doi.org/10.1097/01.RVI.0000248829.49442.0E
17. Rossi S, Giannini F, Passero S, Paradiso C, Battistini N, et al. (1994) Sensory neural conduction of median nerve from digits and palm stimulation in carpal tunnel syndrome. Electroencephalogr Clin Neurophysiol 93: 330-334. https://doi.org/10.1016/0168-5597(94)90120-1
18. Padua L, Lo Monaco M, Valente EM, Tonali PA (1996) A useful electrophysiologic parameter for diagnosis of carpal tunnel syndrome. Muscle Nerve 19: 48-53. https://doi.org/10.1002/(SICI)1097-4598(199601)19:1<48::AID-MUS6>3.0.CO;2-8
19. Levine DW, Simmons BP, Koris MJ, Daltroy LH, Hohl GG, et al. (1993) A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. J Bone Joint Surg Am 75: 1585-1592. https://doi.org/10.2106/00004623-199311000-00002
20. Huskisson EC (1974) Measurement of pain. Lancet 304: 1127-1131. https://doi.org/10.1016/S0140-6736(74)90884-8
21. Evers S, Thoreson AR, Smith J, Zhao C, Geske JR, et al. (2017) Ultrasound-guided hydrodissection decreases gliding resistance of the median nerve within the carpal tunnel. Muscle Nerve 57: 25-32. https://doi.org/10.1002/mus.25723
22. Smith J, Wisniewski SJ, Finnoff JT, Payne JM (2008) Sonographically guided carpal tunnel injections: the ulnar approach. J Ultrasound Med 27: 1485-1490. https://doi.org/10.7863/jum.2008.27.10.1485
23. Trescot AM, ABIPP F, editors (2016) Peripheral nerve entrapments: clinical diagnosis and management. Springer International Publishing, Switzerland. https://doi.org/10.1007/978-3-319-27482-9
24. Marshall SC, Tardif G, Ashworth NL (2002) Local corticosteroid injection for carpal tunnel syndrome. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD001554.pub2
25. Atroshi I, Flondell M, Hofer M, Ranstam J (2013) Methyprednisolone injections for the carpal tunnel syndrome: a randomized placebo-controlled trial. Ann Int Med 159: 309-317. https://doi.org/10.7326/0003-4819-159-5-201309030-00004
26. Peters-Veluthamaningal C, Winters JC, Groenier KH, Meyboom-de Jong B (2010) Randomised controlled trial of local corticosteroid injections for carpal tunnel syndrome in general practice. BMC Fam Pract 11: 54. https://doi.org/10.1186/1471-2296-11-54
27. Wu YT, Ho TY, Chou YC, Ke MJ, Li TY, et al. (2017) Six-month efficacy of perineural dextrose for carpal tunnel syndrome: A prospective, randomized, double-blind, controlled trial. Mayo Clin Proc 92: 1179-1189. https://doi.org/10.1016/j.mayocp.2017.05.025
28. Kirwan J (2001) Is there a place for intra-articular hyaluronate in osteoarthritis of the knee?. The Knee 8: 93-101. https://doi.org/10.1016/S0968-0160(01)00075-8
29. Saltzman BM, Leroux T, Meyer MA, Basques BA, Chahal J, et al. (2017) The therapeutic effect of intra-articular normal saline injections for knee osteoarthritis: A meta-analysis of evidence level 1 studies. Am J Sports Med 45: 2647-2653. https://doi.org/10.1177/0363546516680607
30. Padua L, Padua R, Aprile I, Pasqualetti P, Tonali P (2001) Multiperspective follow-up of untreated carpal tunnel syndrome: a multicenter study. Neurology 56: 1459-1466. https://doi.org/10.1212/WNL.56.11.1459
31. Ortiz-Corredor F, Enriquez F, Diaz-Ruiz J, Calambas N (2008) Natural evolution of carpal tunnel syndrome in untreated patients. Clin Neurophysiol 119: 1373-1378. https://doi.org/10.1016/j.clinph.2008.02.012
32. Gordon T, Brushart TM, Chan KM (2008) Augmenting nerve regeneration with electrical stimulation. Neurol Res 30: 1012-1022. https://doi.org/10.1179/174313208X362488
33. Aulisa L, Tamburrelli F, Padua R, Romanini E, Lo Monaco M, et al. (1998) Carpal tunnel syndrome: Indication for surgical treatment based on electrophysiologic study. J Hand Surg Am 23: 687-691. https://doi.org/10.1016/S0363-5023(98)80056-7
34. Girlanda P, Dattola R, Venuto C, Mangiapane R, Nicolosi C, et al. (1993) Local steroid treatment in idiopathic carpal tunnel syndrome: short- and long-term efficacy. J Neurol 240: 187-190. https://doi.org/10.1007/BF00857526
35. Karadas Ö, Tok F, Ulas UH, Odabasi Z (2011) The effectiveness of triamcinolone acetonide vs. procaine hydrochloride injection in the management of carpal tunnel syndrome: a double blind randomized clinical trial. Am J Phys Med Rehabil 90: 287-292. https://doi.org/10.1097/PHM.0b013e31820639ec