

Iontophoresis Versus Local Injection in Carpal Tunnel Syndrome

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ABSTRACT

The aim of this study was to compare between the effect of iontophoresis and local injection of 2% lidocaine with 4% dexamethasone sodium phosphate on pain perception, active range of motion (AROM), motor distal latency (MDL), and motor conduction velocity (MCV) of the median nerve in people with acute unilateral carpal tunnel syndrome (CTS). Thirty subjects with acute unilateral CTS participated in this study. The results of this study showed significant improvement of wrist movement and reduction in pain and MDL in the acute CTS in treated groups versus control group. The results of this study may suggest the following: 1. The severity of symptoms doesn't correlate with severity of electrodiagnostic abnormalitis 2. Iontophoresis may be considered as a preferable treatment technique in people with acute CTS.

Key Words: Iontophoresis, Injection Carpal Tunnel Syndrome

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy and has become epidemic in the industrial world²⁶. It has become a common condition in clinical practice and its incidence is continuing to rise especially among manual workers who need continuous and forceful flexion of wrist and hand²⁶. It is also common in females more than males as they deal with sewing or typewriting². The prevalence of CTS in occupational disease is of significant proportions. It usually affects dominant hand, commonly seen in jobs that require repetitive motion in the wrist, sustained forceful

contraction of the hand especially in extremes of flexion and vibration exposure²⁶.

Inflammation that cause CTS results in swelling in tendon sheath that cause compression of the median nerve which results in pain and parathesia along the course of the median nerve and reduction of AROM⁵. Also this swelling will increase intra articular pressure that cause abnormal activity of pain receptors. The pain which results from this inflammation is caused by releasing of bradykinin and prostaglandin substances²⁷.

Most of physicians treat this condition with local injection for relief of pain and resolution of inflammatory symptoms¹⁸. On the other hand, local injection has many hazards. It is invasive, painful and may damage nerve inside²⁰. A safe alternative to

local injection is delivering medication by electric current which is called iontophoresis. It has many advantages over injection. It is non-invasive, safe, no needle phobia and concentrates the medication in the target of pathology⁶. Iontophoresis has been its efficacy in treatment of different inflammatory conditions, such as temporomandibular disorders²³, osteo-arthritis¹².

The aim of this study was to compare between the effect of iontophoresis and local injection of 2% lidocaine with 1:100.000 epinephrine and 4% dexamethasone sodium phosphate on pain perception, active range of motion (AROM), motor distal latency (MDL), and motor conduction velocity (MCV) of median nerve in people with acute unilateral carpal tunnel syndrome.

MATERIALS AND METHODS

Design

This study was a pre test - post test research design. It was 4x3 research design. The dependent variables were pain perception, AROM (flexion and extension) of the wrist, MDL and nerve conduction velocity NCV. The independent variables were iontophoresis, control, and local injection.

Subjects

Thirty subjects with acute unilateral CTS participated in this study. They were 28 females and 2 males with age ranged from 30 to 60 years (mean 40 years). They were recruited from El Hussin University Hospital, El Azhar University, CAIRO. Criteria for sample selection were:

Unilateral acute CTS with parathesia at the course of the median nerve distribution at lateral three and half fingers, with severe pain at night.

- No more than one year of history of CTS.
- Motor distal latency of the median nerve vary between 4-6 msec., this indicates acute CTS.
- No open wound, cellulitis, or new surgery at the affected site.
- No past history of allergy to lidocaine or dexamethasone medications.
- No hypertension, diabetes mellitus, acromegaly, hypothyroidism and infective diseases as TB., also exclude patient with fracture in carpal bone that local injection may inhibit healing.

Participants were grouped randomly into three groups of equal number (10 patients each).

Equipment and Materials

1. Phoresor PM 600 (IOMED Co.) with disposable pouch electrode model EL.
2. Electromyograph (EMG), Medelec, 003W005E Sapphire software, upgrade version E, USA.
3. Five inches, plastic universal goniometer (Nova Care).
4. Visual Analogue Scale (VAS).
5. One cc. of 2% lidocaine HCL with 1:200.000 (5 ug/ml) epinephrine 1 cc of 4% dexamethasone sodium phosphat and Saline solution (ASTRA Co., Sodertalje, Sweden).
6. Plastic syringe.

Testing Procedure

The measurable parameters were tested before the first session and one week after the last session (to give time for dexamethasone to work which starts after 24-48 hours after application).

1. Pain perception intensity was measured by VAS which is represented by a line scaled from "0" position which means no pain to

"10" position, which means unbearable pain. The patient was asked to mark at a point which refer to the degree of pain he/she feels.

2. AROM of the affected wrist was measured by 5 inches plastic goniometer. The shoulder and elbow of the tested limb were flexed on 90°, forearm was rested on the supporting surface, hand was free to move and facing the ground, the fulcrum of the goniometer was centered over the lateral aspect of the wrist over the triquetrum. The fixed arm with the lateral midline of the ulna (using olceranon and ulnar styloid process). The examiner supported the goniometer' arms and then the subject was asked to flex and extend his/her hand¹⁵. Normal AROM of the wrist flexion is 80° and for extension is 70°¹³.

3. Motor distal latency (MDL) and nerve conduction velocity of the median nerve was done by the following procedure:

- a. Recording electrodes (surface electrodes). The negative electrode (black) was placed over the muscle belly of abductor pollicis brevis (APB), and the positive electrode (red) was placed over the muscle tendon at the proximal phalanx of the thumb. Ground electrode, which was strapped around the wrist of the other hand.

- b. Stimulating electrode:

At the wrist: at the palmer aspect midway between the tendons of flexor carpiradialis (laterally) and palmris longus (medially), with the cathode 6.5 cm proximal to negative electrode to measure MDL of the median nerve which is normally between 3.2- 3.8 m.sec²⁴. Acute CTS MDL is between 4-6 m.sec¹².

At the elbow: just medial to the brachial artery with the cathode pointed proximally.

To measure NCV from the elbow to wrist:

- measure distal latency from elbow to APB
- then measure the distance between the cathode point at elbow and cathode point at wrist. Subtract distal latency at the wrist from distal latency of elbow.
- finally apply the following equation:

$$NCV = \frac{\text{distance from the elbow to wrist}}{(\text{differences of latencies})} = \text{meter/sec.}$$

Treatment procedure

Every participant in this study received three treatments in three weeks as follows:

Group1: two cc lidocaine/epinephrine with dexamethasone via iontophoresis.

Group2: Same drug (saline) via iontophoresis.

Group3: lidocaine/epinephrine with dexamethasone via local injection (done by rhumatologist).

In all groups, the subject was placed in a comfortable position, sitting on a chair resting affected hand on a table with palm faced upward (forearm was supported in full supination, with wrist slightly extended). The area to be treated was prepared by rubbing it with alcohol, then drying it thoroughly.

RESULTS

The collected data were statistically treated by least square means (LSM), standard error (Ser), difference least square means (DL), analysis of variance (ANOVA) and t-test to study the difference between the three groups

and the difference between variables at $p < 0.05$.

Subjects scores of the independent variables were divided into groups and treated statistically by DLSM (Table 1 and Figure 1).

The following variables were studied:

- 1- Pain perception.
- 2- AROM (wrist flexion/extension).
- 3- EMG changes (MDL & NCV).

Table (1): ANOVA and LSM for all variables in all groups

Variables	G1 LSM		G2 LSM		G3 LSM		F
	Pre	Post	Pre	Post	Pre	Post	
Pain	7.88±0.53	3.28±0.53	7.90±0.53	8.00±0.53	8.20±0.53	4.20±0.53	***
Flexion	61.44±2.56	76.94±2.56	68.50±2.56	66.00±2.56	65.00±2.56	76.50±2.56	***
Extension	46.78±2.46	63.28±2.46	56.50±2.46	58.60±2.46	55.50±2.46	65.50±2.46	***
MDL	5.03±0.24	4.06±0.24	4.48±0.24	5.20±0.24	5.06±0.24	3.87±0.24	***
NCV	52.32±2.55	52.96±2.55	55.81±2.55	52.57±2.55	51.41±2.55	52.20±2.55	N.S.

N.S. = not significant

* = 0.05

** = 0.01

*** = 0.001

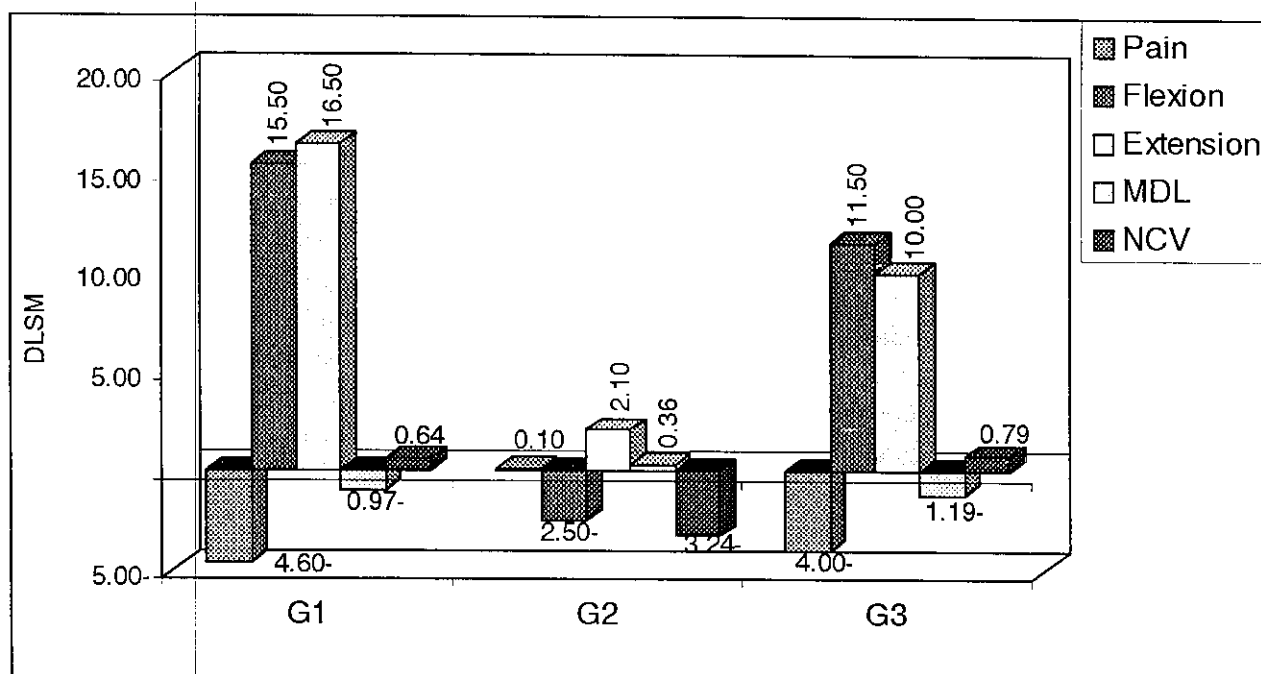


Fig. (1): DLSM (response to treatment) for the variables in all groups.

Inspection of table 1 and figure one reveals the following:

Pain Perception: The results showed that pain measurements was significantly reduced in group 1 (mean -4.5, SD ± 0.59 for 50% reduction) and in group 3 (mean -4.08, SD \pm

0.59 for 50% reduction), and there was no changes in control group 2 (0.03, ± 0.59 for 0.37%).

AROM: Wrist flexion AROM was significantly increased in group 1 (16.88 \pm 1.44 by 27.5%) more than in group 3 (mean 12.26 \pm 1.54 by 20%) and no response in

group 2 (-3.44 ± 1.7 by 5%). Wrist extension AROM was increased in group 1 (14.17 ± 1.53 by 30%) more than that in group 3 (10.95 ± 1.53 by 20%), and slight increase in group 2 (1.55 ± 1.53 by 3%).

Electromyographic Changes: MDL was significantly reduced in group 1 (-0.92 ± 0.23 by 20%) and group 3 (-1.19 ± 0.23 by 24%). No response was detected in group 2 (0.36 ± 0.23 by 7.4%). Nerve conduction velocity (NCV) has no change between pre and post treatment measurements in all groups 1, 2 and 3, -0.8%, -1.6% and 1.5% respectively.

This means that both of iontophoresis and local injection groups had the same effects on reduction of pain perception and MDL, but in iontophoresis group, AROM has more positive effect than that in local injection group. There was no statistically and clinically significant changes.

DISCUSSION

The double effect of lidocaine and dexamethasone in CTS

The same positive significant results obtained from this study in both groups 1 and 3 treated by lidocaine and dexamethasone in different techniques may support the efficacy of these drug treatment in acute conditions of CTS. These results came along with other results of previous studies who supported application of these both medication in treatment of inflammatory conditions. This may be attributed to the simultaneous and combined effect of lidocaine and dexamethasone on resolution of the inflammatory processes (AHFS)¹. The analgesic effect of lidocaine by blocking action on bradykinin and prostaglandin has been reported by Passero²¹. The anti-inflammatory

action of dexamethasone occurs when combines with cellular membrane sites and inhibits prostaglandin formation and secretion Moore et al and Edilby^{8,15} reported that dexamethasone results in greater suppression of swelling that may cause loss of joint motion and restriction of blood supply. Edema as a sequence of CTS is another source of pain. The duration of lidocaine action is 45 minutes while action of dexamethasone starts after 24-48 hours Haynes¹⁴. Therefore, a combination of lidocaine and dexamethasone may give an immediate effect of pain relief with incremental effect supported by the delay action of dexamethasone Sabbahi²³.

The Electromyographic changes in CTS

The results of this current study showed a significant reduction in MDL (improvement) with 1-2 m.sec.,. These findings is supported by Goodman and Foster⁹. Goodman & Foster measured MDL of the median nerve who treated by local injection with mild CTS about 5-7 msec. and moderate to severe 7-10 msec.

There was no changes in NCV in the results of this current study. These results come in agreement with Shin²⁵ who reported that the NCV could be normal in patients with neuropathy of axonal degeneration. The illustration of this findings have been clarified by Gordon et al¹⁰. Gordon stated that acute CTS is characterized by large component of neuropraxia when stimulating proximally and distally to carpal ligament or both motor or sensory nerve or either. Also, Gordon reported that selective involvement of only motor nerve fiber with relatively normal sensory can be a frequent finding. Gordon finally reported that the severity of symptoms didn't correlate with severity of electrodiagnostic abnormalities.

Superiority of iontophoresis in treatment for CTS

The superiority of local steroid injection in idiopathic CTS over intra-muscular route had been supported by Ozdogan and Yazici¹⁹. The superiority of iontophoresis technique over local injection has been supported by McCarty¹⁶ as well as by the results of this current study. This superiority come from infection that may be introduced at the time of injection McCarty¹⁶. Also, post injection flare, tissue necrosis and joint disorganization occur as complication of local injection Bird⁴. Neustadt¹⁸ reported that localized subcutaneous or cutaneous atrophy at injection site may occur, the skin appearance gradually restored to normal when crystals of corticosteroid have been completely absorbed. The clinical significant improvement that has been accomplished in the iontophoresis group may suggest full penetration of the medication to the target of pathology of CTS which come along with the results by Harris¹².

For the safety application of iontophoresis, iontophoresis may be considered as the preferable technique in treatment of patients with acute CTS.

CONCLUSION

The results of this study strongly support the uses of Iontophoresis of 2% Lidocaine with 4% Dexamethason Sodium Phosphat in acute carpal Tunnel syndrome (CTS) than local injection. This effect of lidocaine/dexamethasone iontophoresis can be attributed primarily to full pentratation of the medication to the target of pathology of CTS.

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الملخص العربي

العلاج بالتأين مقارنة بالحقن الموضعي حالات الضغط على عصب الرسغ الأوسط

أجريت هذه الدراسة للمقارنة بين تأثير العلاج بالتأين والحقن الموضعي باستخدام ليدوكاين ٢٪ وديكساميثازون فوسفات الصوديوم ٤٪ على الألم في حالات الضغط على عصب الرسغ الأوسط . ولقد أجريت هذه الدراسة على ثلاثين مريضاً (ثمانين وعشرون رجلاً وأمرتان) قسموا إلى ثلاث مجموعات متساوية العدد . ولقد أكدت نتائج هذه الدراسة مدى كفاءة العلاج بالتأين في حالات الضغط على عصب الرسغ الأوسط الحادة عن الحقن الموضعي وهذا يرجع إلى وصول الدواء إلى هدفه مباشرة .