# Wide Awake Open Carpal Tunnel Release: The Effect of Local Anesthetics in the Postoperative Outcome

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## Abstract

**Introduction** Wide awake open carpal tunnel decompression is a procedure performed under local anesthesia. This study aimed to present the effect of various local anesthetics in peri and postoperative analgesia in patients undergoing this procedure.

**Materials and Methods** A total of 140 patients, with 150 hands involved, underwent carpal tunnel release under local anesthesia. Patients were divided in five groups according to local anesthetic administered: lidocaine 2%, ropivacaine 0.75%, ropivacaine 0.375%, chirocaine 0.5%, and chirocaine 0.25%. Total 400 mg of gabapentin were administered to a subgroup of 10 cases from each group (50 cases totally), 12 hours before surgery. Patients were evaluated immediately, 2 weeks and 2 months after surgery according to VAS pain score, grip strength, and two-point discrimination.

**Results** In all patients, pain and paresthesia improved significantly postoperatively, while the use of gabapentin did not affect outcomes. Grip strength recovered and exceeded the preoperative value 2 months after surgery, without any difference between the groups. No case of infection, hematoma, or revision surgery was reported.

**Conclusion** Recovery after open carpal tunnel release appears to be irrelevant of the type of local anesthetic used during the procedure. Solutions of low local anesthetic concentration (lidocaine 2%, ropivacaine 0.375%, and chirocaine 0.25%) provide adequate intraoperative analgesia without affecting the postoperative course.

**Keywords**
- wide awake hand surgery
- carpal tunnel syndrome
- analgesia
- local anesthetics
- lidocaine
- ropivacaine

## Introduction

Open transverse carpal ligament release for the treatment of carpal tunnel syndrome (CTS) is a common surgical procedure. It may be performed under wide awake local anesthesia and is well tolerated by the patients.[1] Besides, superficial infiltration of the local anesthetic provides adequate intraoperative analgesia.[2] The advantage of using local anesthesia in such surgical procedures is that it allows a rapid turnover of patients and avoids the complications of regional and general anesthesia.

There are many local anesthetics that can be used when performing open carpal tunnel decompression under local infiltration anesthesia and tourniquet control. Previous studies have assessed the pain of skin puncture in local anesthetic injection,[3] and several methods have been introduced to reduce injection pain in carpal tunnel release.[4-6] However, there has been no comparative prospective study of the efficacy of analgesia obtained by several local anesthetics that are used in open carpal tunnel surgery and their impact on patient's intra and postoperative course.

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The aim of this study was to compare the effect of various local anesthetics, in different solution concentrations, in peri and postoperative analgesia in patients undergoing open transverse ligament release for the treatment of CTS.

## Materials and Methods

This prospective study was conducted at the Department of Orthopedic Surgery of a university hospital and a private hospital. The study did not include any experimental investigation with new substances in human subjects and thus, ethical committee approval was not required. Informed consent was obtained from each patient. During the study period 140 patients with 150 hands involved, underwent open carpal tunnel release under local anesthesia from two experienced hand surgeons. There were 112 females and 28 males with ages ranging from 27 to 79 years (mean: 53.7 years). The dominant side was involved in 101 cases (67.3%; ►**Table 1**).

Tinel's and Phalen's signs were positive in all patients, while electromyography (EMG) showed severe or moderate compression of the median nerve in the carpal tunnel. Twenty-three patients (15.3%) had unsuccessful conservative treatment with oral nonsteroidal antiinflammatory drugs (NSAIDs) or paracetamol prior to surgery. Patients with known allergy to local anesthetics were excluded from the study.

The patients were randomly divided into five groups of 30 hand cases each according to the local anesthetic that they received: lidocaine 2%, ropivacaine 0.75%, ropivacaine 0.375%, chirocaine 0.5%, and chirocaine 0.25%. A tablet of gabapentin 400 mg was randomly administered to a subgroup of 10 hand cases of each group (50 hand cases in total) 12 hours prior to surgery (►**Table 1**).

All procedures were performed under tourniquet control at 250 mmHg, as per protocol, and loupes-magnification as outpatient procedures. A single dose of wide spectrum antibiotic (second generation cephalosporin) was administered preoperatively. A 5 mL volume of the local anesthetic solution was injected at a slow rate with a 10-mL syringe and a 23-gauge needle in the subcutaneous tissue under the line of the skin incision in a proximal to distal direction. The skin incision was a limited longitudinal one (approximate length 2.5 cm and range: 2.2–2.8 cm) made in line with the long axis of the radial border of the ring finger extending from the distal crease of the wrist proximally to the Kaplan's cardinal line distally. A thick dressing was applied for 48 hours postoperatively, and free mobilization of the hand was allowed after the third postoperative day, although weight-lifting activities were restricted for at least 4 weeks. Postoperative analgesia protocol involved paracetamol, as first line pain-control, followed by NSAIDs.

All patients were evaluated pre and postoperatively regarding pain, grip strength, and digital sensibility. None of the surgeons were aware of the group in which each patient belonged. Postoperative evaluations were scheduled immediately after surgery at 2 weeks and 2 months after the procedure. Pain was assessed using a 10-cm Visual Analogue Scale (VAS). Grip strength of the involved and uninvolved hand was measured using the Jamar hand dynamometer (Asimov Engineering Co.; Los Angeles, California, United States). Digital sensibility was evaluated with use of two-point-discrimination test. Any adverse sequelae and complications such as wound infections, nerve and vascular injuries, and complex regional pain syndrome (CRPS) were recorded. The use of any analgesics during the postoperative course was also documented.

### Statistical Analysis

A General Linear Model for repeated measurements was applied and significant differences were examined with Unequal N Tukey's HSD test. Significance was set at 0.05 for all tests. A *post hoc* power analysis for the changes over time and between the five different anesthetics/concentrations on the measurements of VAS and grip strength score was conducted with the Gpower v3.1 software. The online research randomizer (*https://www.randomizer.org/*) was used to randomize anesthetics across patients.[7]

**Table 1** Demographic data

| Local anesthetic | Demographic data | | | | |
|---|---|---|---|---|---|
| | Number of hands | Female:Male | Age mean (range) | Right:Left hand operated | Dominant hand operated |
| Lidocaine 2% | 20 | 17:3 | 52.50 (27–79) | 14:6 | 14 |
| Ropivacaine 0.75% | 20 | 17:3 | 54.55 (35–72) | 14:6 | 16 |
| Ropivacaine 0.375% | 20 | 16:4 | 51.65 (29–72) | 12:8 | 12 |
| Chirocaine 0.5% | 20 | 12:8 | 53.80 (33–78) | 14:6 | 14 |
| Chirocaine 0.25% | 20 | 17:3 | 51.30 (35–76) | 15:5 | 15 |
| Lidocaine 2%+GB | 10 | 8:2 | 59.60 (41–74) | 7:3 | 7 |
| Ropivacaine 0.75% + GB | 10 | 9:1 | 59.60 (44–71) | 6:4 | 6 |
| Ropivacaine 0.375% + GB | 10 | 9:1 | 51.50 (39–79) | 6:4 | 6 |
| Chirocaine 0.5% + GB | 10 | 8:2 | 53.80 (41–74) | 4:6 | 6 |
| Chirocaine 0.25% + GB | 10 | 7:3 | 53.3 (35–72) | 4:6 | 5 |

Abbreviation: GB, gabapentin administration.

## Results

A total of 10 of 150 patients underwent CTS release at both hands in separate procedures. The onset of anesthesia was immediate after the subcutaneous injection and was similar among the local anesthetic groups. The average procedure time from skin incision to wound closure was approximately 9 minutes (range: 5–14 minutes) per hand. The upper arm tourniquet was well tolerated in all cases.

None of the patients were lost to follow-up. In all patients, pain and paresthesia improved significantly after surgery. The two-point discrimination test had a gradual improvement over the study period in every group of patients after the transverse carpal ligament release. The mean VAS score for each local anesthetic group is demonstrated in ►**Tables 2** and **3** . No difference was noted between the groups of local anesthetics ($p = 0.96$). In the local anesthetic subgroups that gabapentin was administered preoperatively, the improvement in pain scores followed similar trends to the groups without gabapentin administration ($p = 0.62$; ►**Table 3**). Most patients (90 of 150 hands) reported no pain (VAS = 0) 2 weeks after the carpal tunnel release, regardless of the anesthetic used and the preoperative administration of gabapentin. Only 13 patients in this series used paracetamol (up to 3 g) during the first postoperative day. The use of paracetamol was not correlated to any group of local anesthetics.

The results of the grip strength preoperatively, immediately after surgery, 2 weeks and 2 months postoperatively are shown in ►**Tables 4** and **5**. Although the mean grip strength values in almost each group of local anesthetic had decreased by 15% 2 weeks after surgery ($p < 0.05$ for all groups), they recovered and exceeded their preoperative level by the end of the study (2 months after the procedure). No difference was noted between the groups of local anesthetics ($p = 0.26$).

No case of surgical site infection, hematoma, or revision surgery was reported. None of the patients experienced any local anesthetic-related side effects. In addition, no signs of injury to the median or the digital nerves were noted. Two patients developed CRPS 2 months after the procedure. A regular therapy program was required and ultimately, both patients returned to their normal daily activities.

**Table 2** Visual analogue scale scores (mean values ± standard deviation) for patients without gabapentin administration

| Local anesthetic | Evaluation (mean value [standard deviation]) | | | |
|---|---|---|---|---|
| | Preoperative | Immediate postoperative | 2 weeks postoperative | 2 months postoperative |
| Lidocaine 2% | 7.75 (1.33) | 1.75 (1.65) | 0.90 (1.44) | 0.50 (1.23) |
| Ropivacaine 0.75% | 8.15 (1.49) | 1.80 (1.54) | 0.70 (1.17) | 0.25 (0.78) |
| Ropivacaine 0.375% | 7.95 (1.39) | 1.75 (1.11) | 0.70 (0.73) | 0.20 (0.41) |
| Chirocaine 0.5% | 8.65 (1.42) | 1.90 (2.02) | 0.70 (1.17) | 0.35 (1.08) |
| Chirocaine 0.25% | 8.15 (1.34) | 1.90 (2.31) | 0.70 (1.45) | 0.35 (0.98) |

**Table 3** Visual analogue scale scores (mean values ± standard deviation) for patients with gabapentin administration

| Local anesthetic | Evaluation (mean value [standard deviation]) | | | |
|---|---|---|---|---|
| | Preoperative | Immediate postoperative | 2 weeks postoperative | 2 months postoperative |
| Lidocaine 2% | 8.30 (1.49) | 1.80 (1.31) | 0.80 (1.22) | 0.30 (0.67) |
| Ropivacaine 0.75% | 8.10 (1.19) | 1.70 (1.63) | 0.80 (1.61) | 0.40 (0.69) |
| Ropivacaine 0.375% | 9.0 (1.56) | 2.10 (1.79) | 0.80 (1.31) | 0.20 (0.42) |
| Chirocaine 0.5% | 7.80 (2.04) | 1.5 (1.08) | 0.80 (0.78) | 0.30 (0.48) |
| Chirocaine 0.25% | 8.60 (0.96) | 2.10 (0.87) | 0.70 (0.82) | 0.20 (0.42) |

**Table 4** Pre and postoperative mean grip strength scores (kg) (± standard deviation) for patients without gabapentin administration

| Local anesthetic | Evaluation (mean value [standard deviation]) | | | |
|---|---|---|---|---|
| | Preoperative mean value | Immediate postoperative | 2 weeks postoperative | 2 months postoperative |
| Lidocaine 2% | 30.15 (9.62) | 21.05 (6.56) | 25.65 (6.53) | 32.80 (8.44) |
| Ropivacaine 0.75% | 29.10 (7.55) | 18.00 (5.27) | 24.90 (4.61) | 33.70 (7.14) |
| Ropivacaine 0.375% | 28.65 (10.47) | 17.05 (8.10) | 24.30 (7.34) | 33.90 (8.54) |
| Chirocaine 0.5% | 30.40 (11.52) | 19.20 (6.69) | 25.40 (8.41) | 33.80 (12.49) |
| Chirocaine 0.25% | 28.50 (8.10) | 17.00 (5.21) | 24.20 (6.58) | 33.50 (8.58) |

**Table 5** Pre and postoperative mean grip strength scores (kg) (± standard deviation) for patients with gabapentin administration

| Local anesthetic | Evaluation (mean value [standard deviation]) | | | |
|---|---|---|---|---|
| | Preoperative mean value | Immediate postoperative | 2 weeks postoperative | 2 months postoperative |
| Lidocaine 2% | 25.70 (7.94) | 18.20 (7.28) | 22.10 (7.60) | 27.90 (8.06) |
| Ropivacaine 0.75% | 26.70 (4.83) | 17.10 (4.48) | 22.70 (5.35) | 28.40 (5.46) |
| Ropivacaine 0.375% | 24.60 (7.30) | 14.60 (4.99) | 20.70 (6.18) | 27.10 (6.29) |
| Chirocaine 0.5% | 25.00 (4.76) | 16.70 (2.83) | 21.30 (3.62) | 28.00 (3.77) |
| Chirocaine 0.25% | 29.60 (9.74) | 19.50 (5.52) | 25.00 (5.43) | 33.40 (9.04) |

## Discussion

Carpal tunnel release is performed as an outpatient procedure and thus, the demand of earlier discharge and increased efficiency has led to consideration of alternative anesthesia techniques than sedation (monitored anesthesia care [MAC]).[1] Wide awake carpal tunnel surgery provides significant cost saving with almost the same patients' satisfaction as sedation anesthesia.[8-10] Several regional anesthesia techniques, such as brachial plexus blocks,[11,12] intravenous regional anesthesia,[13] wrist blocks,[14,15] and local infiltration[14-17] have been introduced. The anesthetized area achieved with brachial plexus block seems to be rather excessive for such small size surgical trauma. Intravenous regional anesthesia, although easy to perform, has been associated with severe complications[18] and inadequate postoperative pain management.[19] Wide awake surgery with the use of local infiltration anesthesia in carpal tunnel release is beneficial in providing adequate intraoperative analgesia with high-reported rates of patient satisfaction.[1,20,21] In our study, all patients had significant improvement regarding the VAS pain score postoperatively without any difference between the groups of local anesthetics.

Local anesthetics consist of a lipophilic group (usually a benzene ring) separated from a hydrophilic group (usually a tertiary amine) by an intermediate chain that includes an ester or an amide linkage. The onset, spread, density, and duration of a nerve block are functions of what local anesthetic drug is injected, where it is injected, and for how long the nerve is exposed to it. The duration for carpal tunnel release is, on expert hands, very sort and consequently, we used different concentrations and different local anesthetics to study perioperative analgesia independently of the physical properties of local anesthetics. All three types of local anesthetics are amides and were available and in use at our hospitals. Chirocaine (levobupivacaine) is long acting with an onset of action ≤15 minutes. Lidocaine has a rapid onset of action and intermediate to long duration, while ropivacaine is an amide local anesthetic that may have faster onset of action and longer duration of action than lidocaine.[22,23]

Local anesthetics are widely used for the control of intraoperative and postoperative pain and in the therapy of chronic pain. They have nerve-blocking effects, duration of action, and safety. Also, local anesthetics modulate the overactivity of surgical trauma stress and the sympathetically driven stress response to surgical trauma, and reduce the development of central sensitization. In addition, local anesthetics have antiinflammatory properties and may decrease edema and hyperalgesia caused by local tissue inflammation after prolonged nerve compression. As the inflammation response is the major determinant of patients' postoperative, and chronic, pain after carpal tunnel release, the effects of local anesthetics expand to the first postoperative months.

Although the antiinflammatory mechanisms of local anesthetics are not yet well established, they involve the interruption of nociceptive transmission, direct action on immune cells, blockage of proinflammatory cytokines, inhibition of COX2, and reduction of PGE2 production. Ropivacaine and lidocaine block proinflammatory tumor necrosis factor signaling in endothelial cells.[24-26]

The administration of local anesthetics carries the potential hazard of toxicity because of intravascular injection. Systemic absorption depends on the dose administered into the tissue, the vascularity of the injection site and physiochemical properties of the drug. In our study, systemic absorption was not expected because of the low dose and volume (5 mL) of local anesthetics used. The allergic reactions caused by the administration of local anesthetics depend on their chemical type: ester agents are far more likely to produce true allergic reactions than amides. All agents of the present study were amides and the risk of allergic reactions was decreased.

Several different methods of administering local anesthesia have been reported. Altissimi and Mancini[16] introduced a technique of infiltrating 4 to 5 mL 2% mepivacaine into the carpal tunnel in addition to 3 to 4 mL infiltration of the same anesthetic into the subcutaneous tissue. They reported complete intraoperative analgesia in most patients. Gale[2] suggested that carpal tunnel release could be performed under local infiltration anesthesia by only injecting the local anesthetic into the subcutaneous tissues to avoid median nerve injury. Gibson[27] used bupivacaine (0.5%) with adrenaline in a similar manner and reported slight distress during the incision of flexor retinaculum in 4 of the 98 patients. In our study, a 5 mL volume of the local anesthetic was injected in the subcutaneous tissue under the line of the skin incision without any notable discomfort reported by the patients. Vossinakis et al[28] described higher pain scores with infiltration of unbuffered lidocaine. This difference could be due to the smaller volume of the anesthetic used in our series (5 mL as compared with 15 mL in the study by Vossinakis et al, 2004). According to Scarfone et al,[29] one element of pain from

local infiltration anesthesia is the tension that the volume of the local anesthetic solution causes in the unyielding subcutaneous tissues of the palm, and can be significantly reduced by a slow rate of local anesthetic administration. The fact that we administered the local anesthetic slowly could have also contributed to this divergence.

The use of gabapentin in postoperative pain management has been evaluated in recent studies.[30-36] However, the effect of gabapentin as an adjunct to local anesthesia is unclear and its effects on chronic pain remain unknown. In patients undergoing CTS, we investigated the effects on early postoperative pain of preoperative oral gabapentin as an adjunct to local anesthesia. Gabapentin is an anticonvulsant with antinociceptive and antihyperalgesic properties.[37] Ho et al[35] at a meta-analysis demonstrated that a single dose of gabapentin 1,200 mg or less preoperatively appears to be effective in reducing VAS pain scores in the first 24 hours after surgery. In our study, the use of a single dose of gabapentin 400 mg before the procedure did not affect the pain scores in any group of local anesthetics. There is no obvious explanation for this divergence. It could be due to the fact that surgical procedures differ between our study and those included in the meta-analysis as well as to the different tissue structures, mostly somatic and visceral, involved in the latter study.

It is well known that open carpal tunnel release is associated with loss of grip strength. Our results are similar to those reported in the literature.[38-43] Total 2 weeks postoperatively, all patients presented a 15% decrease of grip strength compared with preoperative values, regardless of the local anesthetic used in the procedure. Grip strength exceeded preoperative levels at the second postoperative month evaluation. The initial postoperative decrease of grip strength is probably related to the role of the transverse ligament as a pulley for the digital flexor tendons.[44-46] In our study, the small skin incision and the careful dissection probably led to a faster healing of the soft tissues, overlying the transverse ligament and likely allowing them to play a substitutional role as pulleys for the function of the flexor tendons within 2 months after the operation.

Several publications focused on complication rates after open carpal tunnel release as well as after endoscopic techniques.[47] Benson et al[48] in a review of the literature from 1966 to 2001 reported that the proportion of complications, performed through endoscopic or open approach, is very low. Especially for structural damage to nerves, arteries, or tendons, the incidence for open carpal tunnel release is 0.49%. In our study, there was no case of median nerve injury or damage of other structures of the wrist and digits. Nevertheless, two patients developed CRPS 2 months after surgery. There are no known specific preventive measures for CRPS after surgery that can be found in the literature. Although some authors have claimed that careful operative technique, avoidance of nerve injury, and proper postoperative mobilization can reduce the frequency of CRPS after surgery,[49] there are no clinical trials that confirm this relationship.[50]

As the smaller solution concentrations of the local anesthetics (ropivacaine 0.375% and chirocaine 0.25%) provided equally good results, we conclude that the use of either lidocaine 2%, ropivacaine 0.375%, or chirocaine 0.25% offer adequate analgesia during surgery and lead to a normal postoperative course.

**Conflict of Interest**
None declared.

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