CARPAL LIGAMENT DECOMPRESSION UNDER LOCAL ANAESTHESIA: THE EFFECT OF LIDOCAINE WARMING AND ALKALINISATION ON INFILTRATION PAIN

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This study investigated the effects of alkalinization and warming of lidocaine 1% on injection pain in patients undergoing carpal tunnel decompression. Sixty-four adult patients were randomly allocated into one of three groups: Group A ($n = 20$) received plain lidocaine 1%, Group B ($n = 22$) alkalinized lidocaine and Group C ($n = 22$) warmed and alkalinized lidocaine. Pain on needle insertion and on infiltration was assessed using a 100 mm Visual Analogue Scale (VAS). There was no significant difference regarding pain on needle insertion whereas significant differences were noted in reference to infiltration pain. In Groups B and C (alkalinized lidocaine) the VAS scores on skin infiltration were significantly lower than in Group A, while the pain score in Group C (alkalinized and warmed lidocaine) was significantly lower than in Group B.

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INTRODUCTION

Carpal tunnel decompression is the most commonly performed procedure in hand surgery. It may be performed by either the open or an endoscopic method using one of several anaesthetic techniques. Many surgeons perform carpal tunnel release under local infiltration anaesthesia and tourniquet ischaemia but concerns exist regarding patient tolerance to local anaesthesia and tourniquet application. Occasionally, the pain experienced on local anaesthetic injection can be significant, causing distress to the patient. Consequently, several methods have been employed to reduce injection pain (Avramidis et al., 2000; Lawrence and Desai, 2002).

Several clinical and laboratory studies have confirmed the favourable effects of alkalinization and warming of local anaesthetic agents on their potency and injection pain. However, to our best knowledge no study, except for a letter to the editor (Vossinakis, 2001), has examined these parameters in carpal tunnel surgery (Chow et al., 1998; Courtney et al., 1999; Mader et al., 1994; Masters, 1998; Michele et al., 1998; Milner et al., 2000; Ririe et al., 2000).

The aim of this study was to evaluate whether lidocaine alkalinization and warming provide better anaesthesia during carpal tunnel decompression.

PATIENTS AND METHODS

This study was performed at the Veterans Army Hospital, Athens, Greece between January 2001 and May 2002 with the approval of the hospital's Ethics Committee. During this period 64 patients were enrolled with clinical and electrodiagnostic evidence of median nerve compression at the wrist. The procedure was performed as a day case in a dedicated department under local infiltration anaesthesia. The patients were randomly allocated to three groups; A, B and C. In each group the total injected volume of local anaesthetic was 10 ml. Nine mililitres of plain lidocaine HCl 1% were mixed with either 1 ml of normal saline 0.9% or 1 ml of sodium bicarbonate 8.4% to produce a final volume of 10 ml. In group A ($n = 20$), local anaesthesia of the palmar skin was performed along the line of the intended skin incision using plain lidocaine 1% mixed with normal saline (Astra, Zeneca), while in group B ($n = 22$) 10 ml alkalinized lidocaine 1% at room temperature (22°C) was administered. In group C ($n = 22$) 10 ml alkalinized lidocaine, previously warmed in a water bath to 40°C for 30 minutes, was injected. The lidocaine was injected slowly over 30 seconds after negative aspiration. The anaesthetic solution was injected through a 25 gauge needle which was inserted into the palmar skin and the anaesthetic solution was injected slowly along the line of the intended skin incision in a proximal to distal direction. The flexor retinaculum was released under direct vision through a 3 cm curvilinear skin incision, extending distally from the distal wrist crease. The skin incision was made 2–3 mm medial to thenar crease, in line with the long axis of the ring finger and the distal palmar wrist crease was never crossed. A forearm tourniquet was always used. In no case was synovectomy or neurolysis performed. The skin incision was sutured with 4–0 non-absorbable sutures and the hand was immobilized for 7 days in a removable splint. Pain was assessed on insertion of the needle and on injection of lidocaine using a 100 mm Visual Analogue Scale

(VAS). The patients were instructed to score a pain-free injection as 0 and the worst pain imaginable as 100. Statistical evaluation was performed using ANOVA and the Scheffe's post hoc test. Data are given as means and standard deviations. Patients were also asked to rate their anaesthetic experience on a scale from 1 (comfortable) to 5 (unbearable) and to answer whether they would be willing to have the same anaesthetic agent injected in their contralateral hand, if they needed the same operation on that side in the future.

RESULTS

There was no significant difference in terms of age, sex and operated hand between the three groups. The mean age of the patients was 61 (SD,8) years and women predominated (51 patients, 79%). The operating room time was 26 (SD,6) minutes and the operation time 12 (SD,5) minutes. There were no significant intraoperative complications. Postoperatively, evacuation of a haematoma was necessary in one patient in group B and a superficial infection in a diabetic patient in group A was successfully treated conservatively. The pain scores on needle insertion and local anaesthetic infiltration were for group A 21 (SD,11) and 42 (SD,12) respectively, for group B 25 (SD,12) and 19 (SD,7) respectively and for group C 21 (SD,4) and 10 (SD,4), respectively. The pain scores on needle insertion were similar for the three groups but infiltration pain in groups B and C was significantly lower than in group A ($P<0.001$). Furthermore, the pain scores on infiltration were significantly lower in group C compared to group B ($P<0.001$). Patients who received plain lidocaine described burning pain on injection, in contrast to the other patients who described deep, pressure pain. Eleven patients from group A (55%) said they would refuse to undergo the same anaesthetic technique on their contralateral hand, whereas in groups B and C only four and three patients, respectively, would have refused.

DISCUSSION

The results of this study indicate that increasing the pH of lidocaine by adding sodium bicarbonate and warming the anaesthetic solution both significantly reduce infiltration pain in patients undergoing carpal tunnel decompression. It is unknown why skin infiltration with local anaesthetics is painful and many authors presume that the pain is a reaction to their acidic pH. Thus, alkalinization and warming of local anaesthetics have been proposed to reduce infiltration pain. Alkalinization also speeds the onset of action, prolongs the duration, enhances the density of the successful block and decreases the pain on injection. Injection pain depends on many factors including needle size, anaesthetic agent, rate of injection, injected volume, injected body area and temperature and pH of the agent. Alkalinization and warming of local anaesthetic solutions is common practice in a number of medical specialties, but not in hand surgery (Callear, 1995; Courtney et al., 1999). Lidocaine buffering appears more important than needle size in decreasing injection pain (Palmon et al., 1998) and alkalinization of plain lidocaine increases its pH from 6.4 to 7.7 (Palmon et al., 1998; Ririe et al., 2000). Several additives (adrenaline, clonidine, ketamine, hyaluronidase, CO_2 and bicarbonates) have been used to increase the anaesthetic potential and duration of the anaesthetic action (Nevarre and Tzarnas, 1998; Ririe et al., 2000; Wood et al., 1999). Addition of adrenaline to lidocaine increases its anaesthetic potential by reducing local absorption, but the acidity of the anaesthetic solution is then increased and as a result its infiltration may become more painful (Nevarre and Tzarnas, 1998; Ririe et al., 2000). Sodium bicarbonate has been added to various local anaesthetics to increase the proportion of the non-ionized form of the drug and allow more molecules to cross cell membranes so as to shorten the latency and increase the potency of the solution. However, excessive alkalinization causes precipitation which decreases the bioavailability of the local anaesthetic and interferes with its activity. For example, ropivacaine at concentrations of 0.75% and 1.0% precipitates at pH 6.0 (Milner et al., 2000). Alkalinization of lidocaine may not accelerate the onset of regional upper limb nerve blockade (Chow et al., 1998) but significantly increases the rate of motor block, without changing the onset or extent of sensory block, when used for a median nerve block (Ririe et al., 2000).

Recently, EMLA has been used in carpal tunnel decompression surgery to reduce injection pain (Avramidis et al., 2000; Lawrence and Desai, 2002). However, it has a few significant disadvantages such as the increased cost and the need to apply the cream 60 to 120 minutes before the operation. Bicarbonate addition is fast and safe and the effectiveness of alkalinized lidocaine in carpal tunnel surgery has been alluded to, though not properly assessed (Vossinakis, 2001). However accidental injection of sodium bicarbonate can cause a serious chemical soft tissue injury. Another simple measure to reduce injection pain is warming of the local anaesthetic to body temperature or slightly higher. Warming and buffering may have a synergistic anaesthetic effect (Callear, 1995; Mader et al., 1994) as suggested by our study. Temperature elevation increases the dissociation constant (Ka) of the anaesthetic solution and decreases the pKa, favouring the presence of the uncharged form of lidocaine (pKa 7.7) that diffuses across the lipid cellular membrane of the neural cell axon (Courtney et al., 1999).

In conclusion, we have found that buffering lidocaine with bicarbonate and warming the anaesthetic solution

helps to reduce pain on infiltration in patients undergoing carpal tunnel decompression.

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