

Alkalinisation of local anaesthetics prescribed for pain relief after surgical decompression of carpal tunnel syndrome

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ABSTRACT

Purpose. To compare the duration of analgesia achieved following administration of buffered prilocaine versus plain prilocaine to patients undergoing surgical decompression of the median nerve.

Methods. 40 (32 female and 8 male; mean age, 50.5 years) patients who underwent surgical decompression of carpal tunnel syndrome were recruited. Patients were randomly allocated to 2 groups: the alkalinised group was given 10 ml of prilocaine hydrochloride 2% buffered with 1 ml of sodium bicarbonate 8.4%, whereas the non-alkalinised group received 10 ml of plain prilocaine hydrochloride 2% solution. Patients were asked to rate their comfort level at the operation site in the first 6 hours following surgery and after discharge from hospital using a

visual analogue scale (VAS). The duration of analgesic effect was evaluated every 3 hours. Additional oral analgesia in the form of paracetamol 500 mg tablets was available to patients if required for breakthrough pain.

Results. Significantly lower VAS scores were reported by the alkalinised group during the first postoperative 12 hours. The change of VAS scores over time was significantly higher in the non-alkalinised group. The mean analgesic requirement for paracetamol tablets in the alkalinised and non-alkalinised groups was 4 and 34, respectively.

Conclusion. Buffered prilocaine provided a longer postoperative pain-free period for patients undergoing surgical decompression of the median nerve. It is easy, safe, and cost-effective.

Key words: alkalinisation; analgesia; carpal tunnel syndrome; median nerve

INTRODUCTION

Chronic median nerve compression following fracture of the distal radius was first described by James Paget in 1854; in 1880 Putnam described 37 patients with median nerve compression; carpal tunnel decompression under local anaesthesia was first performed by Learmonth in 1933.¹ Various methods of local anaesthesia have been described such as plexus blocks, intravenous regional anaesthesia (Bier's block), and local infiltration anaesthesia.² Structure, concentration, pKa, and tissue pH of the local anaesthetic affect its potency, duration of action, and onset of anaesthesia.³ The addition of different agents to local anaesthetics for different purposes has been studied.⁴⁻⁶ Sodium bicarbonate as an alkalisation agent has been used with different local anaesthetics to improve analgesia and accelerate onset of anaesthetic effect.⁷ Hilgier⁷ and Galindo⁸ reported earlier onset and prolonged duration of analgesia with buffered local anaesthetics. The potency of local anaesthetics is determined by the pKa value. Intensive neural blockade is achieved by adjusting the pH value closer to the physiological range.^{3,8}

Most patients who undergo surgical decompression of the median nerve do not require hospitalisation. A pain-free recovery is therefore preferred by both surgeon and patient. This can be achieved by splinting the operated limb, applying a cold pack, or administering parenteral or intramuscular analgesics. Administration of a local anaesthetic for postoperative pain relief is not a routine practice, as surgeons customarily use parenteral analgesia for pain relief. Nonetheless, administration of bicarbonated local anaesthetic is a simple and cost-effective option that is often overlooked.

We aimed to compare the duration of analgesia following administration of buffered prilocaine or plain prilocaine to patients following surgical decompression of the median nerve.

MATERIALS AND METHODS

Between September 2001 and August 2003, 40 (32 female and 8 male; mean age, 50.5 years) patients with carpal tunnel syndrome were recruited. Patients with a history of previous steroid injection into the carpal canal, a distal radial fracture, prior carpal tunnel surgery, diabetes mellitus, or thyroid disease were excluded. The study protocol was approved by the ethics committee of the Dr M Ulker Emergency Care and Traumatology Hospital, Ankara, Turkey. Surgical

decompression of the carpal tunnel was performed for patients who had positive findings on electrodiagnostic study and physical examination.

Patients were randomly allocated to one of 2 groups: the alkalised group was given 10 ml of prilocaine hydrochloride 2% (AstraZeneca, Istanbul, Turkey) buffered with 1 ml of sodium bicarbonate 8.4%. The non-alkalised group was given 10 ml of plain prilocaine hydrochloride 2% solution. The pH values of the anaesthetic agent and mixture were 7.5 in alkalised group and 6.8 in non-alkalised group. All solutions were kept at room temperature. No precipitation was observed after buffering the anaesthetic solution. The surgeon was blinded to the anaesthetic administered to each patient.

Patients were treated as an out-patient without premedication. Haemodynamic variables such as blood pressure, heart rate, and peripheral oxygen saturation were monitored. Curvilinear incisions proximal to distal along the thenar creases were made. The flexor retinaculum was sectioned to completely expose the median nerve, and 1-mm edges from both sides of the retinaculum were removed. No additional synovectomy or internal neurolysis was carried out. No tourniquet was applied, and bleeding at the skin edges was controlled with electrocautery. The skin was closed with interrupted sutures and the hand bandaged. Early motion of the fingers and wrist was encouraged.

Patients were asked to rate their comfort level at the operation site using a visual analogue scale (VAS) [0=no pain and 10=worst imaginable pain] during the first 6 hours after surgery and after discharge from the hospital. All patients were readmitted to hospital for a final evaluation 12 hours after discharge. The duration of analgesic effect was assessed every 3 hours. Patients were asked if analgesia was required and if pain at the surgical site had disturbed their comfort during the first 12 hours following discharge from hospital. Paracetamol tablets (500 mg) were given for pain relief if required.

VAS scores of the 2 groups were compared using the one-way analysis of variance tests. Time-dependent changes of VAS values for both groups were analysed with Mann-Whitney *U* tests. Data are presented as mean and standard deviation. Differences were considered significant if $p < 0.05$.

RESULTS

No significant differences were found between the 2 groups for age, sex, or arm involved (left or right). Respectively in the alkalised group and non-

Table 1
Demographic data of patients

	Alkalinised group, n=20	Non-alkalinised group, n=20
Mean age (range) [years]	48.2 (30–64)	52.8 (42–67)
Sex (male/female)	5/15	3/17
Side (right/left)	16/4	16/4
Operating time (minutes)	21.8	24.2
Analgesia duration (hours)*	11.6	2.1
Paracetamol consumption (tablets)	4	34

* Significantly different (Mann-Whitney *U* test, $p=0.026$)

Table 2
Comparison of visual analogue scale scores of the 2 groups

Hour	Visual analogue scale score		p value
	Alkalinised group (mean, SD)	Non-alkalinised group (mean, SD)	
1*	0	0.5 (0.52)	0.02
3*	0.12 (0.35)	1.75 (1.05)	0.001
6*	1.12 (0.35)	2.16 (1.33)	0.036
12	2.12 (0.83)	2.75 (0.75)	0.06

* Significantly different, one-way ANOVA

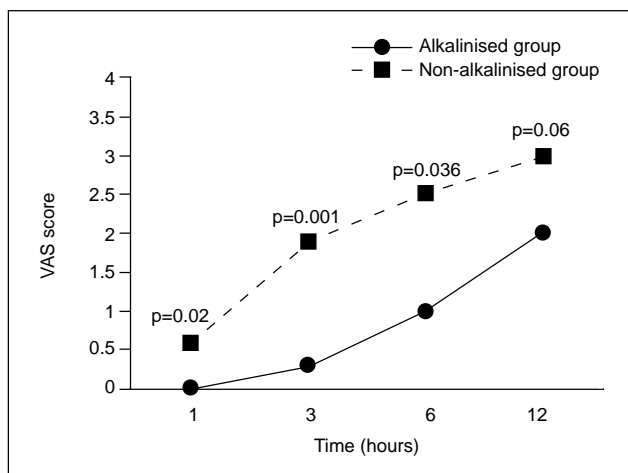


Figure Change of visual analogue scale (VAS) scores over time in the alkalinised group versus non-alkalinised group (Mann-Whitney *U* test, $p=0.026$).

alkalinised group, the mean age of the patients was 48.2 years (range, 30–64 years) and 52.8 years (range, 42–67 years), the mean operating time was 21.8 minutes and 24.2 minutes, and the mean duration of analgesia was 11.6 hours and 2.1 hours (Table 1). The 6- and 12-hour VAS scores in the alkalinised group were 1.12 and 2.12, respectively, versus 2.16 and 2.75 in the non-alkalinised group (Table 2).

Significantly lower VAS scores were recorded in the alkalinised group during the first 12 hours (Table 2). The change in VAS scores over time was significantly higher in the non-alkalinised group ($p=0.026$, Fig.).

The mean analgesic requirement in the alkalinised and the non-alkalinised groups was 4 and 34 tablets, respectively. No significant complications such as methaemoglobinaemia, iatrogenic neurovascular injury, superficial infection, or haematoma were observed.

DISCUSSION

Local anaesthetic solutions comprise 2 forms: uncharged base and charged cationic. The stability of these forms is controlled via varied hydrogen ion concentrations. The acidic form of the drug has an extended shelf life of 3 to 4 years.^{9,10} The uncharged base form is responsible for anaesthetic action, and buffering with bicarbonate increases the uncharged base form and results in early onset and intensive blockade.^{3,11–13} In buffered solutions, amines and amides found in the chemical structure of the local anaesthetic are prone to photodegradation with consequent loss of potency.¹⁰ Therefore, production of prepared buffered solutions of local anaesthetics in factories is not preferred.

Various mixtures of bicarbonate and local anaesthetics and their local application at different sites have been described in the literature.¹⁰⁻¹² Davies¹⁰ reported that the stable ratios of lignocaine 1% and bupivacaine 0.5% buffered with bicarbonate 8.4% were 10:1 and 200:1, respectively. The effects on alkalinisation of local anaesthetics have also been studied. Hilgier⁷ reported efficient blockade and less analgesic consumption following administration of alkalinised bupivacaine for brachial plexus blockade. Although increased potency may relate to an increased nonionic portion of the drug, a high protein binding capacity is also an important property. Thus the vascularity of the administration site may affect the duration of anaesthesia.³

Hilgier⁷ and Galindo⁸ reported low analgesic consumption with alkalinised bupivacaine and mepivacaine solutions, respectively. We achieved a longer duration of analgesia and less analgesic consumption with alkalinised prilocaine compared with plain prilocaine (Table 1). This is comparable with the results of others.^{7,8,14}

The efficiency and stable pH values of various local anaesthetics after alkalinisation have been studied. A stable pH for bupivacaine is 6.8 to 7.0,¹⁵ whereas ropivacaine may easily precipitate and lose its efficacy at a pH value below the physiological level.^{16,17}

Li and Brainard¹⁸ demonstrated that lignocaine could be stored at room temperature but potency decreased after 2 months. Because buffered solutions may lose potency in a short period due to improper storage, buffering should be performed immediately prior to administration.

The duration of postoperative pain relief in patients treated with local infiltration anaesthesia has not been widely studied.^{6-8,14} Nonetheless, pain felt during infiltration with plain or mixtures of

local anaesthetics has been generally studied.^{14,19} Gunetti et al.¹⁴ demonstrated that plain mepivacaine reduced perioperative pain and adjusting the pH value of the drug by adding bicarbonate solution also reduced the pain caused by injection. Yiannokopoulos²⁰ studied the effect of warming plain or buffered lidocaine on infiltration pain and concluded that warming plus alkalinisation could relieve infiltration pain more efficiently by decreasing the pKa of the anaesthetic solution.

This study did not compare patients treated with a long-acting local anaesthetic drug. The effectiveness of such drugs either in plain or buffered forms have already been reported.^{7,11,13,15} The appropriate administration and concentration of the drug and amount in the mixture is still controversial. We aimed to decrease the analgesic requirements for patients discharged from hospital following surgical decompression of the median nerve. A significantly lower VAS score and longer duration of analgesia was observed in the alkalinised group, compared with the non-alkalinised group. Buffering prilocaine raised its pH value from 6.8 to 7.5 and significantly increased the duration of analgesia and decreased the VAS score. The need for post-discharge additional analgesia in the form of paracetamol was also decreased in the alkalinised group (Table 1).

CONCLUSION

Buffered prilocaine provides a longer pain-free period for patients following surgical decompression of the median nerve. It is easy, safe, and cost-effective and it appears that the routine use of alkalinised prilocaine solution in patients undergoing carpal tunnel surgery may improve the comfort and prolong the duration of analgesia.

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