

A clinical evaluation on the alkalization of local anesthetic solution in periapical surgery

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ABSTRACT

Aims: To assess the effect of alkalization of local anesthetic solution for the purpose of enhancing its efficiency in periapical surgery. **Materials and Methods:** A total sample of 80 patients, all needing periapical surgery on one or more of their upper anterior tooth (teeth) was subjected to this trial. For the purpose of comparison, the sample was randomly divided into two groups based on the local anesthetic solution that they were to receive before surgery. The first group (control) included those patients who received the commercially available local anesthetic solution with a standard pH of 3.5. The second group (trial group) included those patients who received a pH adjusted local anesthetic solution at 7.2 (using sodium bicarbonate). Prior to, and at the completion of intended surgery, the following data were recorded: Pain during injection, onset of achievement of surgical anesthesia, pain during operation and the duration of operation itself. **Results:** A significant difference in regard to onset of achievement of surgical anesthesia between both groups was noticed with a faster onset in group two where the patients received a pH adjusted local anesthetic solution when compared to control group where the patients received the commercially available local anesthetic solution. Also, less pain on deposition of solution was noticed in the second group as well as less pain score levels were recorded during operation in regard to the same group. **Conclusion:** The pH adjusted local anesthetic solutions may provide certain advantages when compared to the commercially available local anesthetic solutions regarding enhancement of anesthetic efficiency, reduced pain on injection as well as during surgery.

Key Words: Local anesthesia, alkalinized anesthesia, periapical surgery.

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INTRODUCTION

For periapical surgery to be performed both successfully and as much as possible painlessly, it is an essential requirement that the local anesthetic solution adopted should be potent for an adequate period of time to allow the removal of pathological tissue as well as obturation of the root canal in the tooth and/or teeth that are to be operated on.⁽¹⁾ For this most important purpose, various methods and techniques have been attempted to improve the efficiency of anesthesia, one of which is alkalization of local anesthetic solution.⁽²⁻⁶⁾ The addition of a certain substance to alkalize

the solution thus possibly reducing pain to a minimum during surgery has been described by several studies.⁽⁷⁻⁹⁾ Some of these studies showed that at a higher pH of local anesthetic solution, less pain was experienced by patients during injection, a faster onset of achievement of surgical anesthesia, an enhanced depth as well as an extended period of duration of anesthesia. This was explained by the fact that a neutralized solution would probably reduce pain on injection. In addition, a higher pH local anesthetic solution was associated with a rapid dissociation of its molecules where a higher concentration of ionized anesthetic

agent would cross the nerve cell membrane rapidly to exert its function; hence a more rapid onset of surgical anesthesia as well as increasing its potency. Other studies failed to show any beneficial effect when alkalization of local anesthetic solution was performed in regard to reducing pain on injection and onset of surgical anesthesia.⁽¹⁰⁻¹⁴⁾ Some studies adopting alkalized local anesthetic solutions showed an improvement of properties of local anesthetic solution in regard to reduced pain on injection and onset of surgical anesthesia but failed to show an improved depth of anesthesia during tooth extraction except when assessing the depth of anesthesia for teeth with periapical lesions only.⁽¹⁵⁾ Based on these findings a suggestion was made to assess the effect of alkalization of local anesthetic solution during periapical surgery since this surgery was to be performed on teeth having a periapical lesion.

The purpose of this clinical evaluation was to determine the effect of alkalization of local anesthetic solution on its properties during periapical surgery.

MATERIALS AND METHODS

The clinical evaluation was carried out on subjects attending Department of Oral and Maxillofacial Surgery, Dentistry College, Mosul University. The patients that were to be enrolled in the study complained of one or more symptoms in the apical area of one or more upper anterior teeth. After a final decision was made based on clinical and radiographical examination indicating the possibility of failure of conventional root canal therapy, periapical surgery on one or more upper anterior teeth was to be performed. The patients that were to undergo surgery had no history of systemic disease, no reaction whatsoever to the local anesthetic solution intended to be used and any signs and symptoms of acute inflammation at the site of surgery should be controlled. The subjects were informed of the purpose of this trial and only those who accepted were to participate in this clinical evaluation. The teeth that were to be operated on were opened and any pus was drained through the root canal on a previous visit.

On the day of operation the patients were randomly divided into two groups

according to the type of local anesthetic solution that was to be administered to them. Each dental cartridge that was to be used was labeled with a specific number (single and paired numbers) indicating the type of local anesthetic solution that was to be given. A non-operating member placed three dental cartridges all of which contained the same type of solution beside the surgical instruments; i.e., the operator did not know which type of local anesthetic agent he was to use. Hence, the procedure was to be carried out in a blind way by the operator.

1. Group 1 (control group): Included those patients that were to receive the commercially available local anesthetic solution of a standard expiry date (Xylocaine 2% with 1:80 000 adrenaline in a 1.8 ml solution, the pH of which is 3.5) (Septodont – France).

2. Group 2 (study group): Included those patients that were to receive also the same commercially available local anesthetic solution but at an adjusted pH of the solution at 7.2.

The adjustment of the pH of local anesthetic solution was performed by the addition of sodium bicarbonate (available as 50 ml vial at a concentration of 8.4%, B/Brawn, Germany) and as follows; Using a brand new sterile insulin disposable graduated syringe (1 cc), an amount of 0.1 ml of local anesthetic solution was withdrawn from the dental cartridge in a sterile condition as much as possible and replaced with an approximate amount of sodium bicarbonate. A Philips pH meter (PW9421; Type CEI, Holland) was used for the purpose of pH adjustment. The pH adjusted solution was prepared on the same day of operation and both solutions were coded by a non-operating member to ensure that the operator would not know what solution he was to administer. In regard to the anesthetic technique itself, a supra-periosteal (infiltration) injection was adopted where the solution was slowly deposited over the root apices of the involved tooth / teeth and the adjacent teeth on both sides of the flap that was to be raised. A total number of three dental cartridges was to be given labially. For palatal anesthesia, few drops of local anesthetic solution were given palatally over the roots involved (mostly a nasopal-

atine nerve block injection).

The onset of anesthesia was assessed by deep pressure probing the gingiva overlying the tooth / teeth that were to be operated on using a sharp dental probe until total abolition of pain sensation and as stated by the patient.

Before surgery, the tooth / teeth that were to be operated on were root filled and a coronal restoration was placed. The endodontic surgery was commenced by raising a 3-sided mucoperiosteal flap which involved at least two adjacent healthy teeth. Following careful reflection of the flap, bone removal was performed as necessary to expose the root apex and associated pathology using a round surgical bur with an adequate cooling solution (0.02% Chlorhexidine) which also provided both antimicrobial and haemostatic actions.

Postoperative instructions and necessary medications were prescribed to each patient including antibiotics and nonsteroidal antiinflammatory agents if not contraindicated.

The following data were recorded for each patient:

1. Patient's name, age and sex.
2. Tooth / teeth involved.
3. Indication of operation.
4. Pain during injection of local anesthesia: Pain during injection was evaluated by the patient himself as mild, moderate or severe intolerable pain.
5. Duration of operation: The time recorded from the initial raising of flap to the end of the last stitch placed.
6. Pain grade during operation: This was recorded by the operator and represented the patients pain response during the period of operation according to the Dobb and Devier System⁽¹⁶⁾ and as follows:
 - Grade A:** No pain entirely during the surgical procedure.
 - Grade B:** Mild to moderate pain but tolerable by the patient.
 - Grade C:** Severe pain that was intolerable by the patient and additional anesthesia was administered. In such a situation, intralesional infiltration was given using the same initial injected solution.

The statistical analysis was performed utilizing Student's t-test to determine the significance of difference in regard to onset time of action of solution between the

study and control groups. Chi-square test was used to determine the significance of difference of pain recorded during injection and during operation in between both groups at $p < 0.05$ level.

RESULTS

The number of patients who participated in the clinical evaluation was 80. The ratio of male to female was (1: 1.2). The mean age of these patients was 26. The number of teeth treated in each patient was as follows:

- 1- Three teeth treated in 37 Patients.
- 2- Two teeth treated in 35 Patients.
- 3- One tooth treated in 8 Patients.

This was shown in Table (1).

Table (1): Number of teeth treated in each patient

Number of Patients	Number of Teeth
37	3
35	2
8	1
Total = 80	Total Teeth Treated=189

Mean age of subjects = 26.

The indications of surgery included:

- I- Apparent failure of conventional non-surgical endodontic therapy in 27 patients.
- II- A large periapical radiolucency with limited treatment time noticed in 25 patients.
- III- Failed endodontic surgery in 18 patients.
- IV- In the remaining 10 patients, a large apical radiolucency with a well circumscribed border was seen on periapical radiography raising the suspicion of an apical radicular cyst that needs enucleating. These detailed information concerning the patients were shown in Table (2).

In regard to pain during the injection of solution (Table 3), a significant difference was noticed with less pain experienced in the group that received the pH adjusted solution ($\chi^2 = 14.024$, $df = 3$, $p = 0.001$) when compared with the pain experienced in the control group. For onset of anesthesia recorded in both groups, a significant

difference ($t = 5.9$, $d. f=79$) was noticed with a more rapid onset of action in the study group with a mean onset of action of (133 ± 87 seconds) when compared with

the control group where the mean onset of action was (215 ± 94 seconds). This was shown in Table (4).

Table (2): Rationale for surgical procedure

Rationale for Surgery	Number of Patients
Failure of Conventional Nonsurgical Endodontic Therapy	27
Large Periapical Radiolucency With Limited Treatment Time	25
Failed Endodontic Surgery	18
Large Periapical Radiolucency With Well Circumscribed Border (Apical Radicular Cyst)	10
Total Number of Patients	80

Table (3): Pain grade during injection in both groups

Pain during Injection	Control Group (I) No. (%)	pH Adjusted Group (II) No. (%)	Total
No Pain	5 (12.5%)	12 (30%)	17
Mild Pain	12 (30%)	18 (45%)	30
Moderate Pain	8 (20%)	8 (20%)	16
Severe Pain	15 (37.5%)	2 (5%)	17
Total	40	40	80

$\chi^2 = 14.024$, $df = 3$, $p = 0.001$

Table (4): Onset of surgical anesthesia

Group	No.	Mean \pm SD	t-test
I (Control)	40	215 ± 94	5.9
II (Trial)	40	33 ± 87	

SD: Standard deviation.

In regard to pain grade experienced during surgery for both groups [as shown in Table (5) and the Figure], the results were as follows:

Grade A: This pain score was recorded in 23% of patients in group I (control group), whereas in 62 % of patients in group II (study group).

Grade B: This pain score was recorded in 57% of patients in group I and in 30% of patients in group II.

Grade C: This pain score was recorded in 20% of patients in group I while in only

8% of patients in group II.

This difference in pain assessed during the period of surgery between both groups showed a statistically significant difference with relatively less pain experienced in the study group ($\chi^2=13.25$, $df=2$, $p=0.001$).

When assessing pain grade in both groups in regard to duration of operation (shorter than 30 minutes or 30 minutes and longer), the results as shown in Table (6) disclosed no statistical significant difference between the groups.

Table (5): Pain grade recorded during surgery for both groups

Pain Grade During Surgery	Control Group (I)		pH Adjusted Group (II)		Total
	No.	(%)	No.	(%)	
Grade A	9	(22.5%)	25	(62.5%)	34
Grade B	23	(57.5%)	12	(30%)	35
Grade C	8	(20%)	3	(7.5%)	11
Total	40		40		80

$\chi^2 = 13.25$, $df = 2$, $p = 0.001$.

Grade A: No pain entirely during the surgical procedure. Grade B: Mild to moderate pain but tolerable by the patient. Grade C: Severe pain that was intolerable by the patient and additional anesthesia was injected.

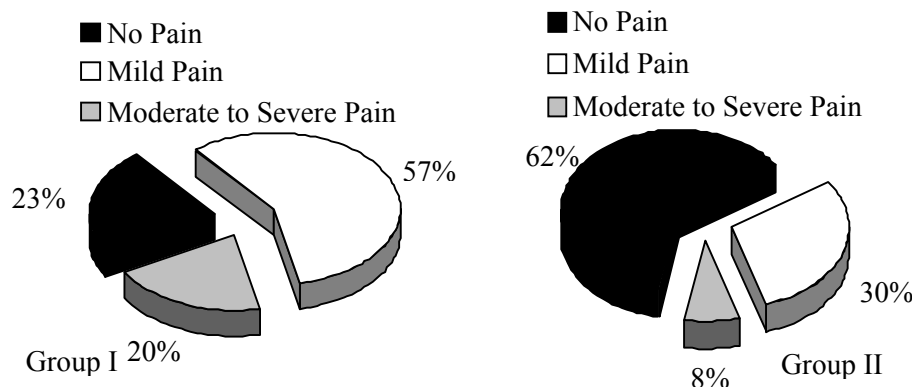


Figure: Pain grade recorded during surgery for both groups

Table (6): Number and percentage of patients in both groups according to duration of surgical operation and different pain grades

Pain Grade	Control Group		Trial Group		Total	
	No. (%)		No. (%)			
	<30 min	>30 min	<30 min	>30 min	<30 min	>30 min
Grade A	6 (15%)	3 (7.5%)	18 (45%)	7 (17.5%)	24	10
Grade B	15 (37.5%)	8 (20%)	5 (12.5%)	7 (17.5%)	20	15
Grade C	4 (10%)	4 (10%)	1 (2.5%)	2 (5%)	5	6
Total	25	15	24	16	49	31
χ^2	0.714 (NS)		0.131 (NS)		0.265 (NS)	

$\chi^2 = 2.19$, $df = 2$, $p = 0.001$ in short operations.

$\chi^2 = 5.16$, $df = 2$, $p = 0.001$ in long operations.

NS: Not significant. Grade A: No pain entirely during the surgical procedure. Grade B: Mild to moderate pain but tolerable by the patient. Grade C: Severe pain that was intolerable by the patient and additional anesthesia was administered.

DISCUSSION

During endodontic surgery, the operator may be faced with some problems which he/she should overcome as quick as possible to complete his/her operation, one of which is inadequate anesthesia. This problem is common especially with the pre-

sence of infection at the site of surgery.⁽¹⁾

One of the benefits achieved by alkalization of anesthetic solution was obtaining a rapid onset of action, which came in acceptance with some studies.⁽²⁻⁴⁾ Although this property may not be necessary but there may come a time where it is required

when there is pain during a surgical procedure and there is a need for reinjection to abolish pain as fast as possible. However, reinjection may sometimes be associated with a high degree of failure due to a number of factors; one of which is acidity at the injection site due to infection. To overcome this, alkalization of the local anesthetic solution at this critical time could be of benefit and a rapid onset of anesthesia is achieved.

Another problem which may be encountered during endodontic surgery is the pain experienced during the deposition of solution and especially in children needing endodontic surgery, mostly for traumatized anterior teeth. Although many children's fear and apprehension comes from the sight of a dental syringe (which even adults fear!), reducing pain on injection of solution as much as possible will gain the trust of the patient which in turn will facilitate other steps of operation. In addition, the administration of excessive amounts of local anesthetic solution (when necessary) as much as 3 dental cartridges of 1.8 ml solution may be associated with pain between each injection. The results of the current study showed less pain experienced in the group of patients who received a pH adjusted solution. This finding came in agreement with several other studies.^(4, 7, 15) Another important criterion to which this clinical trial highlighted on was the highly possible pain experienced during the surgical procedure. Although several studies have stated that alkalization of local anesthetic solution did not improve the depth of anesthesia,⁽⁹⁻¹²⁾ the finding in the current study showed a significant enhancement in the depth of anesthesia which in turn is important for the full completion of a surgical procedure. This may be explained by the fact that in some studies, the anesthetic solution was injected into relatively normal tissue,^(14, 15) whereas in the current study, endodontic surgery was performed on infected tissue which of course will weaken the anesthetic solution due to the acidic environment. Alkalization of solution may overcome this problem where a suitable alkaline media is provided for the anesthetic agent closer to its dissociation constant (pKa) to increase the rate of dissociation of the agent into base form which passes

more rapidly and penetrating the nerve sheath at a higher concentration.^(1, 2, 9)

The possible benefit of alkalization of an anesthetic solution for the purpose of increasing the duration of anesthesia as much as possible was also assessed in the current study. The results of this clinical trial disclosed that there was no beneficial effect of alkalization of anesthetic solution in regard to increasing its duration of action. This came in agreement with the results of Backer *et al.*⁽¹⁰⁾ Several factors play a major role in increasing the duration of a dental procedure including the difficulty of operation, age of patient, size of lesion, number of teeth....etc. The results showed no significant difference in regard to the duration of operation within the same group and between the two groups.

CONCLUSION

Alkalization of anesthetic solutions may provide a good method for improving the properties of local anesthesia during endodontic surgery and especially in the presence of chronic infection or when surgery is to be performed on a child patient.

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