ISSN: 1812–1217

Effectiveness of pH adjusted lidocaine versus commercial lidocaine for maxillary infiltration anesthesia

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ABSTRACT

In this study, alkalinizetion of commercial local anesthetic solution was attempted in order to determine its effect on onset and pain experienced during injection as well as its effect on depth of anesthesia achieved for maxillary tooth extraction. Total 200 patients participated and randomly distributed into two groups, 100 patients for each. The first group received maxillary infiltration anesthesia for extraction of maxillary tooth with commercial local anesthetic solution at pH 3.5, and the second group received the same injection with alkalinized solution to pH 7.2 using sodium bicarbonate 8.4%.

The result of this study showed a significant rapid onset in pH adjusted group comparing to control group. Significant difference noticed between both groups regarding pain noticed during injection with less pain experienced in study group. No significant difference in the depth of anesthesia achieved. When data assessed for patients with periapical lesion only, a significant difference noticed between pH adjusted group comparing to control group and less pain recorded during extraction with enhanced depth of anesthesia achieved in study group.

In conclusion, pH adjusted anesthesia, although not recommended routinely, co-uld be used to reduce injection pain when severe pain on injection expected. Also, it could be used for patient with periapical lesion to enhance depth of anesthesia.

Key Words: Anesthesia, pH adjustment, alkalinization, neutralization.

الخلاصة

في هذه الدراسة، تم معادلة حامضية المخدر الوضعي المتوفر تجارياً كمحاولة لتحديد تأثير ذلك على سرعة عمل المخدر وكذلك تأثيره على الألم المصاحب لعملية زرق المخدر الموضعي إضافة لتأثيره على كفاءة المخدر. شارك ٢٠٠ مريض وزعوا عشوائياً على مجموعتين كل واحدة ١٠٠ مريض: المجموعة الأولى أعطيت مخدر موضعي اعتيادي بدرجة حامضية ٣.٥ والثانية أعطيت مخدر موضعي ذي حامضية متعادلة (٧.٢) بواسطة بيكاربونات الصوديوم ٨.٤% (أعطي المخدر لقلع سن في الفك العلوي فقط).

أظهرت نتيجة البحث فروقات معنوية بسرعة عمل المخدر عند المجموعة التي أعطيت المخدر متعادل الحموضة أكثر منها عند المجموعة الضابطة. أظهرت الدراسة فروقات معنوية بالنسبة للألم المصاحب لزرق المخدر أيضاً (اقل عند المجموعة المستخدمة للمخدر المتعادل). لم تظهر فروقات معنوية بالنسبة لشدة الألم خلال القلع عند المجموعتين، لكن عند تحليل النتائج بالنسبة للمرضى الذين لديهم خمج نهاية الجذر فقط، فقد ظهرت فروقات معنوية لصالح مجموعة الدراسة حيث كانت شدة الألم أقل عند مجموعة الدراسة خلال عملية القلع.

بالنتيجة فإن المخدر الموضعي المتعادل على الرغم من عدم الحاجة إليه دائماً لكن يُنصح باستخدامه لتقليل الألم خاصة عند توقع ألم حاد ببعض أنواع

التخدير وكذلك عند وجود خمج في نهاية جذر الأسنان.

INTRODUCTION

The administration of local anesthesia is frequently uncomfortable. The acidic pH of solution plays a significant role in provoking discomfort during injection. Other roles include the site of injection and amount of injected solution.[1] The addition of substance to alkalinize the solution and thus reduce the pain of injection had been attempted by several studies.[2–12] Some of these studies showed that at high pH less pain experienced, enhanced depth achieved and extended duration resulted as well as rapid onset of action of anesthesia.[2–9] Other studies fail to show any beneficial effect for alkalinization on pain and onset.[10–12]

Two strategies have been employed for alkalinization: Either addition of sodium bicarbonate or carbon dioxide. Alkalinization will increase rate of dissociation of local anesthetic molecule and then increase uncharged base form that cross nerve membrane to the intra–neuronal site where exert its action.[9, 13, 14]

Several studies showed that local anesthetic formulation of pH 7.2 had onset of less than 2 minutes comparing to 5 minutes onset for commercial local anesthetic solution (pH = 3.5–4.5).[15, 16] However, such alkaline formulation had disadvantage of precipitation of local anesthetic molecule and inadequate shelf life (less than 2 weeks). This side effect of alkalinization made manufacturer produced local anesthetic on stable acidic form (pH = 3.5–4.5).[9]

Most of studies use pH adjusted local anesthetic solution in ophthalmic and hand surgery. Only one study uses this preparation in dentistry.[14] This study aims to use freshly alkalinized local anesthetic solution during tooth extraction to determine the effects of alkalinization on its properties including pain associated with injection, onset of anesthesia and depth of anesthesia achieved.

MATERIALS AND METHODS

The clinical study conducted at College of Dentistry/University of Mosul/Oral and Maxillofacial Surgery Department. Patients selected were those need single maxillary tooth extraction and should be free from any history of systemic disease. Informed consent obtained about participation in clinical study. After complete history taken and extra– and intra– oral examination, each patient receives an injection of local anesthesia by the same dentist. Local anesthesia injected supra–posteriorly; labially, buccally and palatally as indicated for each individual case (one cartridge used for each patient). Patients assigned randomly to one of the following groups according to the solution used:

Group A: Local anesthesia (xylocaine 2%) with 1:80 000 adrenaline at pH = 3.5 (Septodent, Fosses Cedex, France).

Group B: Local anesthesia (xylocaine 2%) with 1:80 000 adrenaline at adjusted pH = 7.2 (Septodent, Fosses Cedex, France).

Adjustment performed by using sodium bicarbonate. About 0.1 ml of local anesthetic solution expelled and replaced by sodium bicarbonate 8.4% (B/Braun/ Melsungen AG–Germany). Phillips pH meter (PW9421; Type CEI) used for pH adjustment.

Both solutions were coded by second person and both the dentist and patient didn't know the type of solution to make double blind study (Fresh solution used and new sample prepared and used at the same day).

After injection of local anesthesia assessment of onset of achievement of anesthesia performed using sharp explorer to separate gingival crevices from the tooth and recording time from injection to the complete loss of pain sensation.[17] Following achievement of successful anesthesia, extraction of indicated tooth performed and the following information recorded for each patient:

Tooth anesthetized.
Diagnosis of tooth.
Onset of achieving anesthesia (in seconds).
Pain during injection.
Pain during extraction.

Pain recorded during injection obtained by asking the patient after completion of injection about pain sensation

during injection and recorded as either: No pain, mild, moderate or severe intolerable pain.

Pain record during extraction recorded by the dentist who noticed pain response of patient during extraction and recorded as either:

No pain (successful anesthesia)
Mild pain (no additional anesthesia needed)
Moderate to severe pain where additional anesthetic injection needed.[18]

RESULTS

In this study 200 patients participated, 70 males and 130 females with age range between 16–52 years. Teeth involved in the study were as follows: Sixteen upper central incisors, 24 lateral incisors, 20 canines, 72 premolars and 68 molars. Diagnoses for tooth indicated for extraction were shown in Table 1.

Mean onset time for achieving anesthesia in study group (93 $\pm$ 15 seconds) showed to be significantly less than that of control group (182 $\pm$ 24 seconds) (t = 5.62, d.f = 99).

Table (1): Number of teeth according to the diagnosis for extraction

Diagnosis	Number of Teeth
Acute Pulpitis	27
Chronic Pulpitis	50
Acute Periapical Lesion	18
Chronic Periapical Lesion	43
Chronic Periodontitis	62
Total	200

Table (2) showed the degree of pain during injection in both groups. Significant difference noticed with less pain achieved in group received pH adjusted solution.

Table (2): The degree of pain recorded during injection in both groups

Pain during Injection	Control Group (A)	pH Adjusted Group (B)	Total
No Pain	30	56	86
Mild Pain	36	24	60
Moderate Pain	20	14	34
Severe Pain	14	6	20

$\chi^2 = 14.5$, d.f = 3, $p = 0.002$.

When assessing the degree of pain during extraction in both groups, although mild pain and no pain records noticed much higher in study group comparing to control, this difference noticed not statistically significant (Table 3).

When assessing pain recorded during extraction in patient had periapical lesion, it showed a significant difference between control group and group injected with pH adjusted solution. The result showed less pain experienced in study group with significant difference comparing to control group (group A). (Table 4 and Figure)

Table (3): The degree of pain recorded during extraction in both groups

Pain during Extraction	Control Group (A)	pH Adjusted Group (B)	Total
No Pain	31	36	67
Mild Pain	29	40	69
Moderate to Severe Pain	40	24	64

$\chi^2 = 0.877$, d.f = 2, $p = 0.64$.

Table (4): Difference in pain recorded during extraction in both groups for tooth with periapical lesion

Group	Control Group (A)	pH Adjusted Group (B)	Total
No Pain	3	12	15
Mild Pain	9	16	25
Moderate to Severe Pain	15	6	21
Total	27	34	61

$\chi^2 = 10.55$, d.f = 2, $p = 0.005$.

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Vol. 4, No. 1, 2004

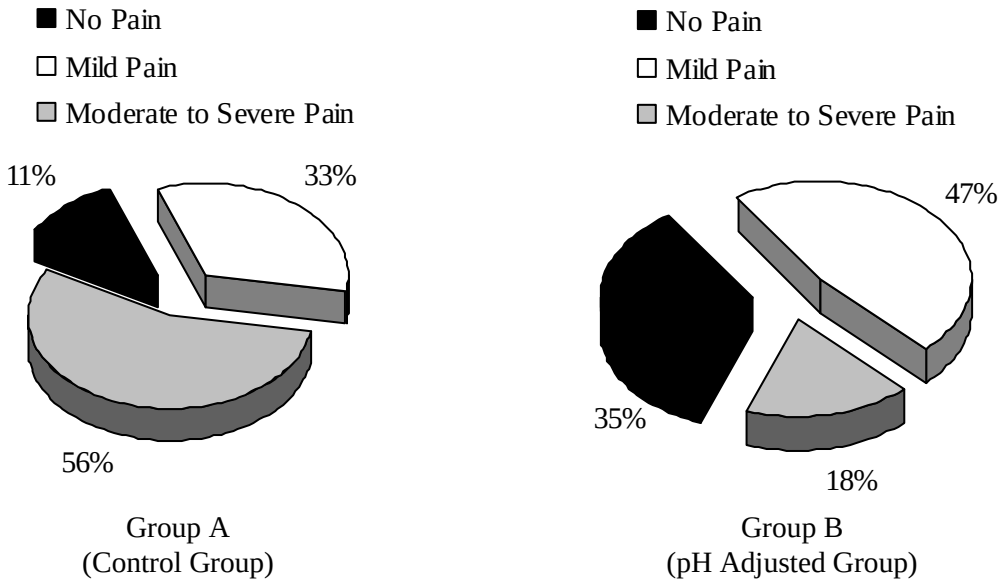

Figure: Difference in pain recorded during extraction in both groups for tooth with periapical lesion

DISCUSSION

In this study only single maxillary teeth indicated for extraction enrolled. This proposed for standardization of amount of solution injected and technique of injection since various types of injection produce different pain as well as difference in onset and depth of anesthesia between infiltration and nerve block anesthesia is clear.[1–14]

Rapid onset of achieving anesthesia in group received pH adjusted anesthesia noticed in the study agreed with several other studies. [7, 9, 13] These studies stated that rapid dissociation will occur at pH 7.2 comparing to pH 3.5 of commercial local anesthetic used in this study. The advantage of rapid onset of anesthesia could be obtained and thus limit time of patient waiting and also reduce patient pain especially that associated with acute pulpits which exacerbated by intra–oral examination.

The aim of reducing pain of injection is of significant importance since 50% of patients fear and apprehension from dental treatment related to the fear from injection of local anesthesia.[19] In this study, pain associated with injection of local anesthesia showed to be significantly less in group injected by pH adjusted local anesthetic solution when compared to control group. Most of available studies accept this result.[2–9]

Therefore, the reduction of the injection pain may not only encourage patient to attain to dental clinic but also reduce most important dental complication which is fainting or vasovagal attack which occur due to stress and fear.[19]

Other advantage of alkalinization of anesthetic solution is the enhance depth of

anesthesia by increasing amount of dissociated free base to penetrate nerve membrane. In this study, no significant difference noticed between study and control groups. This result agreed with other studies.[15, 16] However, when assessing data concerning teeth with periapical lesion only, it showed a statistically significant difference. This could be explained as that in periapically infected teeth anesthetic resistance was expected due to poor anesthetic dissociation by acidic pH at infected site. This problem overcome by pH adjusted solution.[3, 9] This could explain the failure to achieve difference between both groups in other studies in which every tooth with different pathology involved in the study,[15, 16] whereas only those with periapical lesion will show clear difference only.

These results may suggest the use of this type of solution for tooth with periapical lesion when treatment of this tooth indicated under local anesthesia. Also, it could be used to reduce injection pain especially in area where pain expected like during palatal injection.[1]

CONCLUSION

The alkalinization of local anesthesia, although provide minor benefit, but it could be used in indicated situations like periapical infection, when rapid onset needed and in apprehensive patients, yet it requires time to prepare the anesthetic solution. Further studies on its effect on nerve block anesthesia are indicated.

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Received: 27/3/2004 ***Accepted for Publication: 10/5/2004***