Age limit for infiltration anaesthesia for the conservative treatment of mandibular first molars. A clinical study on a paediatric population

**ABSTRACT**

**Aim** The aims of this study were to assess the age limit for infiltration anaesthesia as an effective technique in treating carious lesions of first permanent molars in the paediatric age and if differences exist between males and females.

**Materials and methods** A total of 51 teeth from 48 different patients aged between 6 and 14 years were included in the study. The anaesthetic solution used was 1.8 ml of 2% mepivacaine with 1:100000 epinephrine. The effectiveness of anaesthesia was assessed by electrical pulp test after 3, 5, 7 and 10 minutes.

**Results** In 56.9% of the treated cases a single mandibular infiltration was sufficient to induce complete pulpal anaesthesia of the tooth to be treated. Under 10 years of age, the infiltration technique was effective in 85.2% of cases. The success rate of anaesthesia also decreased significantly and not linearly in function of age. The success of infiltration anaesthesia was not related to gender.

**Conclusion** Mandibular infiltration anaesthesia is a successful technique for most patients under 10 years (success rate: 85.2%) especially for the younger ones, with no differences between males and females. After this age that success rate dramatically drops.

**Keywords** Community paediatric dentistry; Restorative dentistry/dental materials; Pain control; Sedation.

### Introduction

It is now widely accepted that, particularly in paediatric dentistry, one of the most important aspects in managing the cooperation of patients is pain control [Aminabi et al., 2009]. To date tooth decay is a disease which requires a widespread care among the population, in particular in the socially disadvantaged classes [Ferro et al., 2010; Ferro et al., 2012].

The most commonly used local anaesthetic techniques are inferior alveolar nerve block (IANB) and buccal infiltration. Truncal anaesthesia may, however, affect children’s cooperation and has some disadvantages [Hallonsten et al., 2004; including longer duration of anaesthesia, a higher frequency of self-induced injuries such as biting of the lip or tongue and a degree of difficulty that makes the injection stressful for both the clinician and patient [Yassen, 2010]. The usual technique of IANB is also associated with additional risks and complications such as nerve or vascular injury, intravascular injection, muscle injuries and myofascial pain, more frequently than other local anaesthetic techniques [Lustig and Zusman, 1999; Manfredini et al., 2011]. On the other hand, pulpal anaesthesia through buccal infiltration can be reached only if the anaesthetic solution is able to spread from the periosteum to the apexes of the teeth through the thickness of cortical bone [Manani, 2003] and therefore its success depends on the thickness and density of the alveolar cortical bone [Lloyd Du Brul, 1988].

Due to the structure of mandibular cortical bone, the effectiveness of infiltration anaesthesia for mandibular molars has traditionally been considered unsuitable for dental procedures in adults [Abdulwahab et al., 2009; Hawkins and Moore, 2002]. In children bones are less compact than in adults, and the mandibular cortex is crossed by many canals; the anaesthetic solution can spread more quickly and smoothly, helping the effectiveness of the infiltration techniques [Council on Clinical Affairs, 2005; Malamed, 2004].

Several studies evaluating the use of mandibular infiltration as an alternative to inferior alveolar nerve block in deciduous dentition concluded that the two techniques do not differ significantly [Donohue et al., 1993; Naidu et al., 2004; Oulis et al., 1996; Yassen, 2010].

Maki et al. [2000], demonstrated that the volume
and density of mandibular cortical bone increase significantly with age; whereas cortical volume in 9 to 11-year-old children appears to be approximately 33-35% compared to that of adults, it increases up to 83-87% between 15 and 17 years of age. Ono et al. [2008] and Fayed et al. [2010] confirmed that the mandibular cortical bone is less thick in adolescents than in adults. Moreover Swasty et al. [2009] indicate that mandibular cortical thickness is not fully mature and does not reach its peak until the third decade of life, and that the cortical bone thickness decreases after the fifth decade.

Maki et al. [2000] and Fayed et al. [2010] demonstrated that cortical bone develops differently in females and males. While under 11 years of age there are no differences with regard to gender, in the following years in male subjects the cortical bone develops more, both in volume and density, than in females [Maki et al., 2000]. The increase of bone’s thickness during the developmental age has not been investigated so deeply up to now. The use of new devices for radiographic examinations, such as cone-beam volumetric tomography, will provide more information with a high reduction of the radiation dose compared to the traditional ones [Tomasi et al., 2010]. In a sample of 43 patients aged 13 to 48 years, mean age 24.0 ± 8.2 years, Ono et al. [2008] found that mesially in the first lower molar the average cortical bone thickness ranged from 1.59 to 2.66 mm.

The purpose of this study is to assess the age limit for infiltration anaesthesia as an effective technique in treating carious lesions of first permanent molars in the paediatric age and the presence of differences between males and females.

Materials and methods

The subjects included in this study were selected with these following criteria.

Age between 6 and 14 years.

Presence of caries in mandibular first permanent molars, which had not resulted in pulp necrosis or irreversible pulpitis and the treatment of which required the administration of local anaesthesia.

Cooperative behaviour.

A total of 51 teeth from 48 different patients (19 males and 29 females, mean age 10.2 ± 2.3 years) were included in the study. The efficacy of anaesthesia was assessed by electrical pulp tester (Digitest Parkell®); to improve the conduction between the device and the tooth, a small amount of water-soluble ultrasound gel (Eco Supergel Ceracarta) was applied on the metal tip of the device.

For delivery of local anaesthesia by buccal infiltration the following were used: reusable, non self-aspiring metal syringes, 30G 0.3 x 16 mm needles and 1.8 ml of 2% mepivacaine with 1:100000 epinephrine.

The pulp test firstly evaluated the initial vitality of the affected tooth and the corresponding contralateral tooth, to ensure that the instrument and the patient’s responses were reliable. Infiltration anaesthesia was performed at the level of the molar, and then the pulp sensory threshold to the pulp test stimulation was evaluated after 3, 5, 7 and 10 minutes. If the device reached the maximum output intensity of electric current (value 64 on display), without the patient experiencing the stimulus, anaesthesia was considered effective. If after 10 minutes, the pulp sensitivity represented by the value of the pulp tester at which the patient felt the stimulus remained unchanged or nearly so, anaesthesia was considered unsuccessful. On the contrary, if after 10 minutes the pulp sensory threshold had significantly decreased (at least 80% on the instrument scale, corresponding to value 51) the operator waited 5 more minutes before taking further control of pulpal sensitivity.

Descriptive analysis presenting percentages (absolute numbers) for categorical variables and median (inter-quartile difference) for continuous variables was performed. Variable distribution was compared among successful and unsuccessful anaesthesia using chi-square test of Wilcoxon test whenever appropriate. Association of probability of successful anaesthesia was estimated using a logistic regression model and modeled using restricted cubic spline. Non-linearity was assessed using the AIC criterion. Residual sensitivity at time 3, 5, 7 and 10 minutes after anaesthesia was estimated using a proportional hazard model and depicted using a Kaplan-Meier function. All analyses were performed in R System [R Development Core Team (2010). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/] using Harrel’s Design libraries [Regression Modeling Strategies by FE Harrell (Springer-Verlag, 2001)].

Results

In 29 cases out of 51 (56.9%) a single mandibular infiltration was enough to induce complete pulpal anaesthesia of the tooth to be treated.

Successful buccal anaesthesia did not vary according to patient’s gender (Table 1).

Probability of a successful infiltration anaesthesia decreases significantly and non-linearly (Fig. 1) as a function of age (OR 0.02 95% C.I. 0.01-0.18); which means that up to 10 years of age the gradual reduction of the probability of success is small. This probability, however, falls significantly in older subjects. If, in fact, in the age group between 6 and 10 years the success rate reaches 85.2% of cases, while in the age group between 11 and 14 years it goes down to only 25%.
Residual sensitivity after anaesthesia was at a median level of 42 (37-64+ 95% CI) after 3 minutes, 61 (55-64+ 95% CI) after 5 minutes and 64+ after 7 minutes from anaesthesia (only 4% of the patients showed a residual sensitivity after 10 minutes) (Fig. 2).

**Discussion**

The first permanent molar is the most caries-susceptible tooth in the young permanent dentition [Mejàre and Stenlund, 2000; Ong and Bleakley, 2010], with lesions occurring generally within the first 3 years after its eruption. This study demonstrates the possibility of using buccal infiltration instead of IANB in paediatric patients for the treatment of caries of the mandibular first permanent molars.

As infiltration anaesthesia in patients aged between 6 and 10 years was successful in 85.2% of the cases, this technique can be considered an effective procedure in younger subjects (Fig. 1).

This outcome is related both to lower density and thickness of cortical bone in this age group [Fayed et al., 2010; Maki et al., 2000; Ono et al., 2008; Swasty et al., 2009], and presumably to the process of root growth, which in the case of first permanent molars is completed at the age of 9-10.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>N (Residual Sensitivity)</th>
<th>N (Effective Anaesthesia)</th>
<th>Combined</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender: m</td>
<td>51 44% (12) 33% (8) 39% (20)</td>
<td>0.417</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>51 11.00/12.00/13.00 7.75/8.00/9.25 8.00/10.00/12.00</td>
<td>&lt;0.001</td>
<td></td>
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</tr>
<tr>
<td>Tooth: 46</td>
<td>51 48% (12) 50% (12) 49% (25)</td>
<td>0.895</td>
<td></td>
<td></td>
</tr>
<tr>
<td>initial</td>
<td>51 5.00/10.00/14.00 5.75/9.00/16.00 5.00/9.00/14.00</td>
<td>0.661</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X3 minutes</td>
<td>49 10.00/17.00/25.00 25.50/37.00/43.25 16.00/25.00/37.00</td>
<td>&lt;0.001</td>
<td></td>
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<tr>
<td>X5 minutes</td>
<td>51 11.00/19.00/34.50 50.75/60.50/64.00 19.00/38.00/59.00</td>
<td>&lt;0.001</td>
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<tr>
<td>X7 minutes</td>
<td>41 12.5/27.0/43.5 64.0/64.0/64.0 19.0/47.0/64.0</td>
<td>&lt;0.001</td>
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<td>X10 minutes</td>
<td>16 40.25/45.50/52.25 64.00/64.00/64.00 40.75/48.00/53.25</td>
<td>0.02</td>
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</table>

**FIG. 1** Mean fracture resistance (and Standard Deviation) values and modes of failure registered in the experimental groups.

**FIG. 2** Residual sensitivity (continuous lines) and respective 95% Confidence Intervals after 3 (dark red), 5 (red), 7 (orange) and 10 minutes after infiltration anesthesia.
Therefore in children of this age group, the buccal infiltration anaesthesia in the mandible could be recommended not only for the deciduous dentition [Donohue et al., 1993; Oulis et al., 1996; Yassen, 2010], but also for the first permanent molars.

The significant decrease in the success rate (only 25%) of infiltration anaesthesia that occurs between 11 and 14 years could be related to thickening of cortical bone in this area.

We expected differences in response between males and females on the basis of the studies of some authors, such as Maki et al. [2000] and Fayed et al. [2010], demonstrating a different thickness and density of cortical bone between gender; however, our study did not present any differences in response between males and females.

Conclusion

This is the first study to demonstrate that the infiltration technique should be used as a possible alternative to mandibular block anaesthesia in the majority of carious lesions of the mandibular first permanent molars in patients under 10 years of age.

This paper suggests buccal infiltration as an alternative means to IANB for achieving anaesthesia of the mandibular first permanent molar in young children, being the former less stressful and offering less complications and lower risks of affecting children’s cooperation than the latter.

References