

Aspiration in Intra-Ligamental Anaesthesia of Lower First Molar Teeth: A Pilot Study

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Abstract

Aims: This pilot prospective, randomised, crossover study of positive aspiration frequency in intra-ligamental anaesthesia (ILA) was conducted with the following aims: (1) to determine the frequency of positive aspiration of blood after the administration of ILA at lower first molars, and (2) to evaluate the depth of the pulpal anaesthesia of lower first molars after positive or negative aspiration of blood, using electro-testing.

Methods: Intra-ligamental anaesthesia with 4% articaine with epinephrine was administered to the lower first molars of 36 dental student participants. Pulpal analgesia of these 36 molars (17 left and 19 right) was obtained after 114 intra-ligamental insertions, with 3.2 insertions on average, with the help of a computer syringe. The depth of pulpal analgesia after each insertion administration was assessed with electro-testing.

Results: A total of 114 intra-ligamental needle insertions were administered, of which 44 led to pulpal analgesia. After up to five administrations of ILA, all 36 molars achieved pulpal analgesia. In 34 of 36 (94.4%) subjects, ILA was accompanied by a positive aspiration test (AT). In the other two cases, successful but slow onset pulpal analgesia was obtained after five intra-ligamental needle insertions but with negative ATs.

Conclusions: For the first time, the aspiration of blood after the administration of ILA has been studied. The frequency of positive aspiration of blood and successful pulpal analgesia was 94%. There was a very strong association between positive aspiration of blood after ILA and good pulpal analgesia. When there was negative aspiration of blood after the administration of an ILA, in rare cases pulpal analgesia developed after a delay of 3-5 minutes. However, in general, negative aspiration of blood indicated that pulpal analgesia had not been achieved.

Key Words: Aspiration, Intra-Ligamental Anaesthesia, Intra-Vascular Injection, Pulpal Analgesia

Introduction

During infiltration and inferior dental block local anaesthesia an aspiration test (AT) is necessary to prevent hitting a blood vessel with the needle and to exclude the possibility of subsequent rapid intra-vascular injection of local anaesthetic solution, which can produce toxic complications. Aspiration is an important factor in local anaesthesia safety, which—according to American Dental Association [1]—is a desired element of injection and according to Malamed (2004) [2] it is obligatory.

In some countries, the use of intra-ligamental anaesthesia (ILA) has become widespread [3]. However, if the intra-ligamental technique involves penetration into spongy bone, it is impossible to carry out aspiration with a pressor syringe, as its

design has no mechanical connection between the piston rod and the rubber plunger of the cartridge. Nevertheless, Malamed (2002, 2004, 2011) [2,4,5] has suggested that when intra-ligamental, intra-osseous and intra-septal local anaesthesia have been accomplished normally, “aspiration risk is zero.” On the other hand, Petrikas et al. (1973, 1989, 2011) [6-8] have shown that when supplementary local anaesthesia is provided with intra-septal and intra-osseous injections, there is almost always positive aspiration of blood. This observation has been supported by the results of other studies [9-11].

Assuming that ILA has a vascular mechanism, it is expedient to observe any association of positive and negative aspiration of blood with the effectiveness of pulpal analgesia obtained. Mandibular

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molars are frequently the most difficult to anaesthetise [2,7,8,12] and are therefore of special interest in this respect. Electro-testing is a technique that can be used to estimate pulpal analgesia [12].

Aims

Against this background the aims of this study were:

1. To determine the frequency of positive aspiration of blood after the administration of ILA into bone at lower first molars.
2. To evaluate the depth of the pulpal anaesthesia of lower first molars after positive or negative aspiration of blood, using electro-testing.

Methods

Thirty-six dental student volunteers (17 males and 19 females, aged 19-24 years) participated in the study, all of whom were fit and well with no relevant medical history. All were informed of the goal of the study and signed a written consent. The study was approved by the Ethical Committee of the Tver State Medical Academy.

Four per cent solutions of articaine with epinephrine, either 1:100,000 or 1:200,000 (Ubestesin, 3M ESPE)—both concentrations are equally efficient [10]—were used for ILA. The injections were delivered by means of computer injector (Quicksleeper; Dental Hi Tech, Cholet, France) (*Figure 1*) without rotation of the needle and into bone at the base of the gingival sulcus. The ILAs were administered to all subjects by one clinician (MDV). The needles were 9 mm in length and 0.3 mm in diameter. Teeth with gingivitis, large restorations, and/or endodontic treatment were excluded. The Quicksleeper had a uniform speed of injection, which was 1.0 ml LA in 102 seconds. The insertions were administered at the mesial and distal sides of the lower first molar teeth (17 on the left and 19 on the right side). If pulpal analgesia was not achieved after one administration, between one and three supplementary ones were given [10]. Aspiration was achieved with a reverse of the piston rod of the syringe for 5 seconds.

Electro-odontometry (EOM) (pulp testing) was conducted before and for 30 seconds after the ILA insertion. The IVN-98 Pulpotest-Pro (Cascade, Russia) pulp tester was used. The threshold of pain sensitivity was defined after each insertion by series of impulses of alternative electrical current (50 Hz), the strength of which in microamperes

(mkA) was gradually increased until the feeling of pain occurred. The criterion for pulpal analgesia was a threshold value of 100 mkA [13]. A maximum value of 200 mkA represents complete pulpal anaesthesia.

Statistical analysis of the results was carried out with *t*- and chi-square tests and statistical significance was set at $P < 0.05$.

Results

ILA was successful in all 36 lower molars. It was achieved with from one to five insertions, on average 3.2, as well as with an increase in the injected dose from 0.4 to 1.2 ml, on average 0.7 ml. In two cases, anaesthesia was obtained after one (the first) insertion. All effective ILAs, after one and sometimes two insertions, were accompanied by positive aspiration of blood. Positive AT was observed as a thin blood stream or pink colour of the anaesthetic solution in cartridge (*Figure 1*).

Positive aspirations of blood were seen in 34 of 36 (94.4%) of the participants, after ILAs that led to pulpal analgesia. A positive AT was noted after 50 (43.9%) of the 114 insertions. A negative AT was noted after 64 (56.1%) insertions (*Table 1*).

Table 1. Positive and negative aspiration tests in intra-ligamental anaesthesia with 4% articaine with epinephrine in the presence (+) and absence (-) of pulpal anaesthesia

Aspiration	Pulpal analgesia (+)	Pulpal analgesia (-)	Total needle insertions
Positive (AT+)	42	8	50
Negative (AT-)	2	62	64
Total	44	70	114

Chi-square = 7.75; $P < 0.01$

After positive ATs (50 needle insertions), pulpal analgesia was obtained on 42 (84%) occasions. In 35 (70%) of these positive ATs, a maximum value of 200 mkA (complete sensitivity exclusion) was observed and in the other 7 (14%), thresholds were reduced, from 102 to 180 mkA. After 8 (16%) needle insertions, EOM values did not achieve pulpal analgesia level although they were relatively high, from 60 to 90 mkA.

After negative AT (64 needle insertions), EOM values in 62 (97%) cases were lower than the 100 mkA level. Nevertheless, in two (3%) cases, after 3-5 minutes, pulpal analgesia was observed

with EOM values of 100 and 110 mka. In only two cases with a positive AT, pulpal analgesia ensued immediately after the only needle insertion and EOM values were the maximum of 200 mka (Figure 1). Changes in the average EOM indices together with the results of statistical testing depending on positive or negative aspiration are shown in Figure 2.

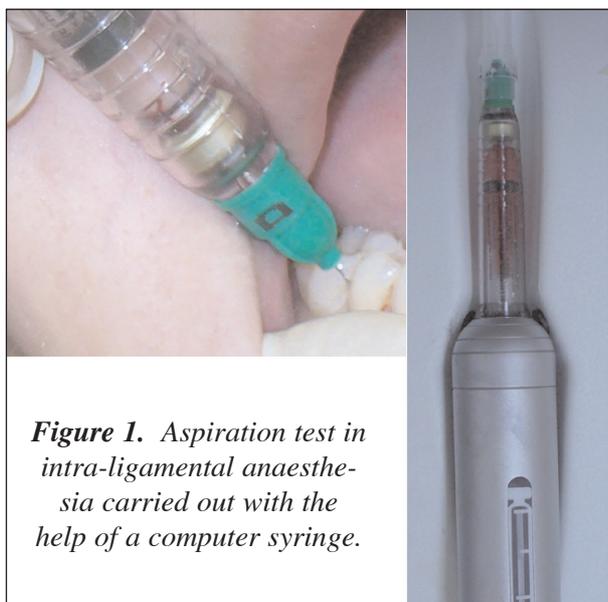


Figure 1. Aspiration test in intra-ligamental anaesthesia carried out with the help of a computer syringe.

Average values of EOM in 36 cases after 50 ILAs with positive aspiration were 171.6 ± 7.9 mka

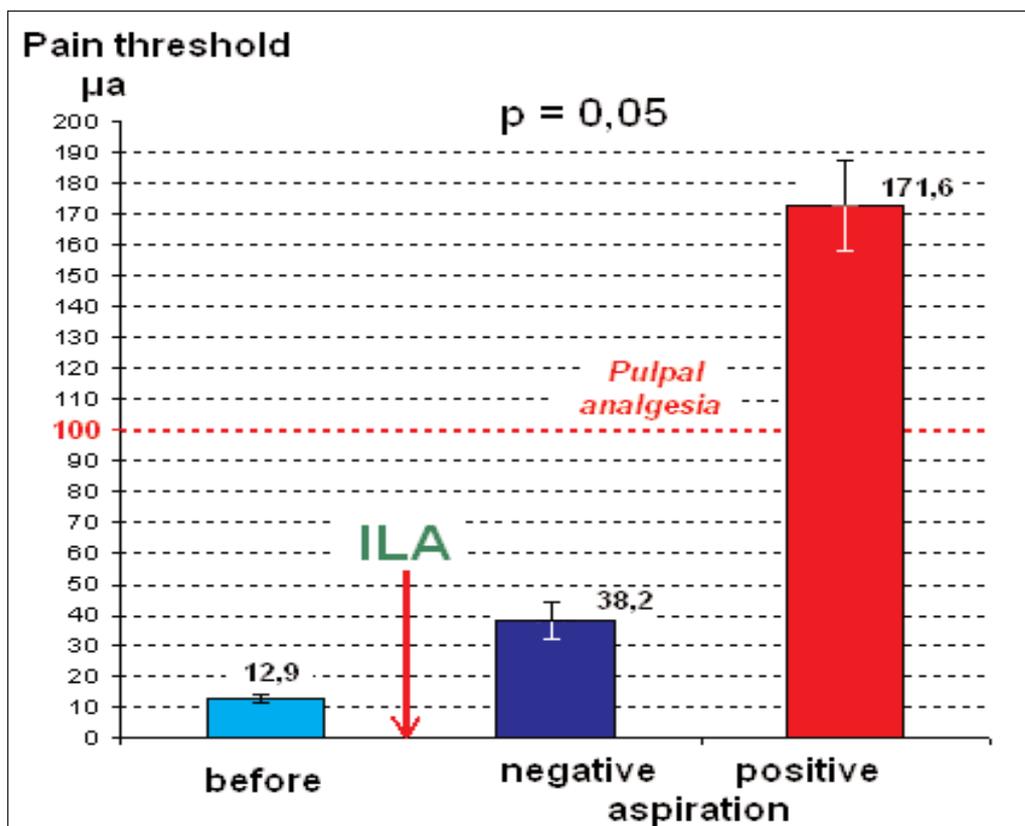
and exhibited a negative AT after 64 needle insertions (38.2 ± 3.4 mka). A highly significant difference between these values was apparent ($P < 0.001$). EOM values for needle insertions with negative aspiration increased when compared to their initial values before the anaesthesia. EOM values for needle insertions with positive aspiration increased as compared to the values before ILA and to the values with negative aspiration.

Discussion

In 34 of 36 (94.4%) participants, intra-ligamental anaesthesia of the lower first molar was almost always achieved after several insertions (total 114). Absolute success of the injections was achieved due both to several insertions and also to an increased dose of ILA.

The finding that no blood was aspirated after successful pulpal analgesia in only two of the participants is contrary to the findings of Malamed (2002, 2004, 2011) [2,4,5]. In the other 34 participants, blood was aspirated after successful pulpal analgesia. Previously, Petrikas (1987) [7] observed positive aspiration in intra-septal anaesthesia, Yakupova (2006) [9] in intra-osseous anaesthesia, and Efimova (2011) [11] in intra-septal anaesthesia. As a rule, when there was positive aspiration of blood, there was pulpal analgesia and, in contrast,

Figure 2. Average values of pain threshold with confidence interval ($P=0.05$) in electroodontometry (μa) of the lower first molar before (green bar) and after intra-ligamental anaesthesia (ILA) in the cases of positive (red bar) or negative (blue bar) aspiration in 114 needle insertions of 4% articaine with epinephrine.



negative aspiration was almost always associated with insufficient anaesthesia. In the relatively small group that took part in this study, there was a highly statistically significant probability of a direct association between aspiration of blood after the administration of ILA and successful pulpal analgesia.

After two administrations of ILA, pulpal analgesia developed without blood in the syringe (AT: negative). This may have been due to injection pressure and diffusion (infiltration) of the local anaesthetic, without an evident vascular component. In contrast, after two ILA administrations, complete pulpal analgesia, with a positive AT, occurred almost immediately after just one administration. In the remaining cases, it seems likely that the mechanism for pulpal analgesia was a mixture of a vascular component plus diffusion of the local anaesthetic. Nevertheless, if it is gauged by positive aspiration of blood, the vascular component was far more likely to lead pulpal analgesia than that of diffusion. The anatomy of the roots of lower first molars may well be a factor in these findings.

The absence of pulpal analgesia with positive AT in 8 (16%) of 50 injections in the presence of sufficiently high values of pain threshold to electrical current was probably due to the fact that the anaesthetic came into contact with the apex of only with one of the two first molar roots.

Application of EOM appeared to be a useful technique to aid reliable controlled pulpal analgesia. When it gave low readings, the administration of supplementary ILA led to pulpal analgesia.

In this study, the findings came from 114 aspiration tests and were confirmed by EOM. As previously mentioned, they contradict the findings of Malamed 2002, 2004, 2011 [2,4,5]. Further work is needed to resolve these conflicting results

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Conclusions

1. For the first time, the aspiration of blood after the administration of ILA was studied. The frequency of positive aspiration was 94%.
2. There was a very strong association between positive aspiration of blood after ILA and good pulpal analgesia.
3. When there was negative aspiration of blood after the administration of an ILA, in rare cases pulpal analgesia developed after a delay of 3-5 minutes. However, in general, negative aspiration of blood indicated that pulpal analgesia had not been achieved.

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Contributions of each author

- MDV planned the conceptual model for the study and its design, administered the ILA, analysed the results, drafted and redrafted the paper, and approved the final version.
- DMV planned the conceptual model for the study and its design, analysed the results, drafted and redrafted the paper, and approved the final version.
- AZP planned and supervised the study, critically reviewed its drafts, and approved the final version.

Statement of conflict of interest

As far as the authors are aware, there is no conflict of interests.

<http://www.iusb.edu/~sbdental/Local%20Anesthesia/Supplementary%20Injections.ppt>

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