Eur Arch Paediatr Dent (2014) 15:121–126
DOI 10.1007/s40368-013-0073-0

ORIGINAL ARTICLE

Mandibular block success rate in relation to needle insertion and position: a self-report survey

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Received: 19 June 2013 / Accepted: 17 July 2013 / Published online: 6 August 2013
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Abstract
Aim To evaluate possible associations between successful mandibular block injection and location of penetrating the oral mucosa, location of injection on the ramus and the needle insertion length.
Study design The study consisted of 101 dentists, of whom, 33 were oral surgeons, 33 certified paediatric dentists and 35 general dental practitioners. The dentists were asked to estimate their rate of success in mandibular block injections, defined as the proportion of their patients for whom only a single carpule was necessary, and to indicate the needle insertion length and the location of the injection on a photograph of a ramus and on a photograph of the oral mucosa.
Results Injecting a single carpule for achieving full anaesthesia in 90 % or more of their patients was reported by 79.3 and 57.8 % of the dentists treating children and adults, respectively. Of practitioners treating children, experienced dentists (>5 years in occupation) reported higher success rates than did inexperienced ones ($p = 0.05$). A positive correlation was found between failure rate reported in children, shorter length of the inserted needle ($R = 0.356$, $p = 0.001$) and injecting at the central (superior inferior dimension) most anterior quarters of the ramus ($p = 0.006$; odd ratio = 3.9375). Routine waiting period of more than 5 min after the injection and before operative treatment was associated with higher rates of failure ($p = 0.042$, $\chi^2 = 6.335$).
No correlation was found between the success rates of mandibular block injection and the location of penetrating the oral mucosa in children ($p = 0.94$), adults ($p = 0.57$), or between success rates and the target location on the ramus in adults ($p = 0.42$).
Statistics χ^2 test was used to determine the significance of differences among proportions and t test for continuous variables. Pearson's correlation analysis was used to analyse the correlation between the length of the needle inserted in children and adults by the same dentist.
Conclusions Shorter needle insertion lengths and targeting the injecting to the most anterior quarters of the ramus were positively correlated with failure of anaesthesia in children, according to dentists' reports. A routine waiting period of over 5 min did not increase the success rates of mandibular block injection.

Keywords Inferior alveolar nerve · Injection · Local analgesia

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Introduction

The inferior alveolar nerve block, also known as mandibular block injection (MBI) is the procedure most routinely used for anaesthetising mandibular posterior teeth, yet the

documented success rate is only 63–87 % (Kaufman et al. 1984; Childers et al. 1996). To achieve complete anaesthesia, the local analgesic solution should be delivered as close as possible to the mandibular foramen (MF). However, researchers disagree on the exact location of the MF in the antero-posterior dimension. Although approximately half of the studies on adults show that the MF is located posterior to the mid-line of the ramus (Hayward et al. 1977; Hetson et al. 1988; da Fontoura et al. 2002; Fujimura et al. 2006; Ashkenazi et al. 2011), the other half positions it at the mid-line of the ramus (Sweet 1943; Monheim 1969; Weiss 1972; Ricketts 1975; Nicholson 1985). Moreover, there is disagreement regarding the existence and degree of positional changes of the MF in the anteroposterior dimension during child development. Changes during childhood in the MF location of the antero-posterior dimension have been evaluated in only four studies. In a study conducted in the United States, analysing cephalometric radiographs, the percent of depth of the MF between the anterior and posterior areas of the ramus did not change significantly with age (Benham 1976). In contrast, Tsai (2002, 2004) reported, in a Taiwanese population, that the MF moves anteriorly with age. Harrison (1948) concluded from measurements of 51 developing mandibles [15 with primary dentition (age up to 6 years), 29 with mixed dentition (6–13 years), and 7 with permanent dentition], that the length of the posterior ramus increased with age from an average of 9 mm in primary dentition to 16 mm in permanent dentition. Nevertheless, she stated that techniques for inferior alveolar injection should not rely on fixed measurements for obtaining either the correct insertion point or the depth of insertion of the needle necessary to reach the sulcus. In a recent analysis of 121 dry mandibles with primary, mixed and permanent dentitions, Ashkenazi et al. (2011) found that the MF distance from the posterior border of the ramus increased significantly with age by 66 % from the primary (mean of 7.75 mm) to permanent dentition stage (mean of 12.9 mm) ($p < 0.001$).

Based on the available data, Malamed (2004) and McDonald et al. (2004) recommended injecting the mandibular block more posteriorly in children than in adults. Although Pinkham et al. (2005) mentioned that the MF is located at the mid-line of the ramus and changes with age, they did not detail the change.

The length of the needle that should be inserted in the tissue during mandibular block injection is recognised as important for precise location of the MF; however, there is also disagreement in the literature in this regard. Malamed (2004) recommended inserting a 20–25 mm long needle to a depth of about 2/3 to 3/4 its total length. McDonald (2004) recommended inserting 15 mm of the needle's length, and Jorgensen and Hayden (1980) did not mention the needle's length at all. No study has been performed to evaluate the relationship of needle insertion length and successful anaesthesia.

The aims of the present study were to examine possible associations between the success rate of mandibular block injection and needle insertion length, the site target of penetration in the oral mucosa and the site of injection on the ramus, according to a self-report survey.

Materials and methods

A total of 101 dentists participated in the present study, of whom, 33 were certified oral surgeons, 33 certified paediatric dentists and 35 general dental practitioners. A structured anonymous questionnaire was designed to assess demographic details including age, gender, number of years from graduation, post-graduation specialty, number of years from completing specialty or from graduation, age of patient population (children or/and adults). An experienced practitioner was defined as one who had been practicing for at least 5 years.

The dentists were asked to mark on photographs the length of the needle they usually inserted into the oral mucosa during mandibular block injection and the location of the injection on the oral mucosa (Fig. 1) and on the ramus (Fig. 2). The illustrations of the needles (short and long) were in 1:1 dimension. To estimate the location of injection on the oral mucosa and the ramus, the dentist received a picture of the oral mucosa and a ramus (without the MF, which was erased by Photoshop); the sites of injection in the oral mucosa and the ramus were marked with grid lines. The ramus was divided into four quarters in anterior posterior dimension and in vertical dimension

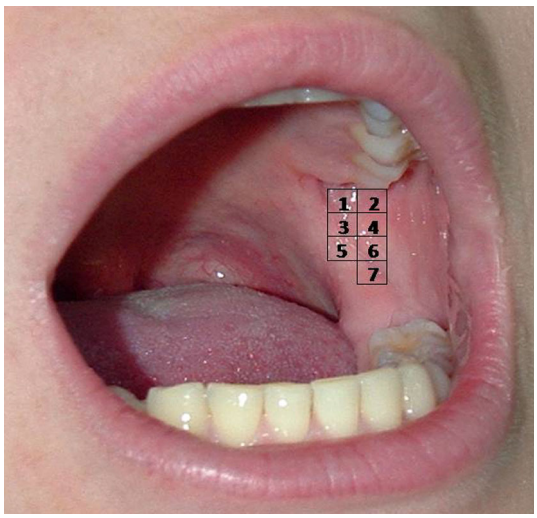


Fig. 1 Illustration of oral mucosa for indicating the site of injection during mandibular block anaesthesia

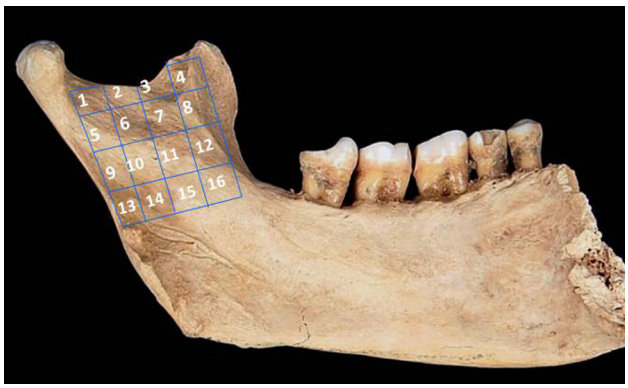


Fig. 2 Illustration of mandibular ramus for indicating the site of injection during mandibular block anaesthesia

(total 16 squares). Dentists who treat both children and adults were asked to mark the length of the inserted needle and the location of injection on the oral mucosa and on the ramus on two different illustrations (Figs. 1, 2).

Dentists were asked to report separately for children and for adults, the duration of time they waited from completion of the injection until initiation of treatment, to estimate the percent of their patients for whom the injection of only one carpule suffices for achieving full anaesthesia with MBI, and to estimate the frequency that they interpreted a complaint of pain as pressure sensation.

The present study was approved by the ethics committee of the Chaim Sheba Medical Center, Tel Hashomer, Israel.

Statistical analysis

We performed univariant analysis using the χ^2 test to determine the significance of differences among proportions (location of injection, gender) and Student's *t* test for continuous variables (success in analgesia, years of work, length of needle). Pearson's correlation analysis was used to analyse the correlation between the length of the needle inserted in children and adults by the same dentist.

The data were analysed by SPSS 10.0 (SPSS, Inc., Chicago, IL, USA).

Results

Study population

The study included 101 dentists, of whom 59 (58.4 %) were males and 42 (41.6 %) females. The mean ± SD age of the dentists was 42.9 ± 10.4 (range 26–72 years). Duration of practice was 15.5 ± 10.5 (range 1–46 years). Of them, 30 (29.7 %) reported that they treated only children, 20 (19.8 %) only adults and 51 (50.5 %) both children and adults. Thirty-five were general practitioners, 33 paediatric dentists and 33 oral surgeons.

Success rate for achieving full anaesthesia

The distribution of dentists who reported injecting more than one carpule to achieve full anaesthesia in mandibular block injection is presented in Fig. 3.

Of the 81 dentists, who treated children, 64 (79 %) reported successful rates of anaesthesia (1 carpule sufficed for achieving full anaesthesia in at least 90 % of their patients), compared with 41 of 71 (57.8 %) of the dentists who treated adults. Considering only paediatric dentists and general practitioners, and not the oral surgeons, the success rate increased to 82.1 % (46/56) for dentists, who treated children and 64.0 % (32/50) for those who treated adults.

Of the dentists participating in the study, 36 (35.6 %) reported that they interpreted a complaint of pain as a sensation of pressure in more than 10 % of their cases.

Correlation between the location of the penetration of the oral mucosa and successful anaesthesia in MBI

The distribution of dentists penetrating different locations in the oral mucosa during mandibular block delivery is presented in Fig. 4. More dentists reported penetrating the oral mucosa in the anterior half of the chart (62 vs. 30 %) and in the lower half of the chart (67 vs. 39 %) when treating children than adults (Fig. 4). No correlation was found between the reported location of penetration in the oral mucosa and reported successful rates of anaesthesia (injection of only 1 carpule for achieving full anaesthesia in at least 90 % of their patients following MBI) for children ($N = 81$, $p = 0.94$) and for adults ($N = 71$, $p = 0.57$).

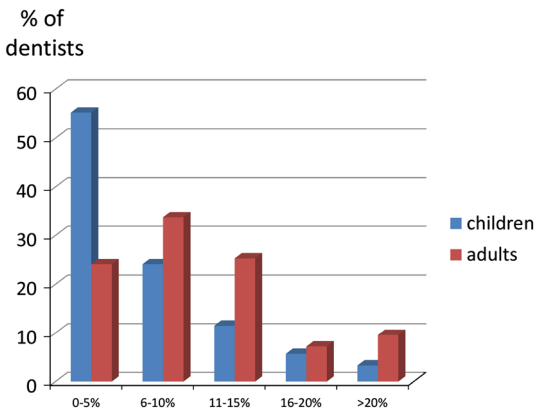


Fig. 3 Distribution of dentists (%) injecting more than one carpule for achieving full anaesthesia in mandibular block injection in children and adults

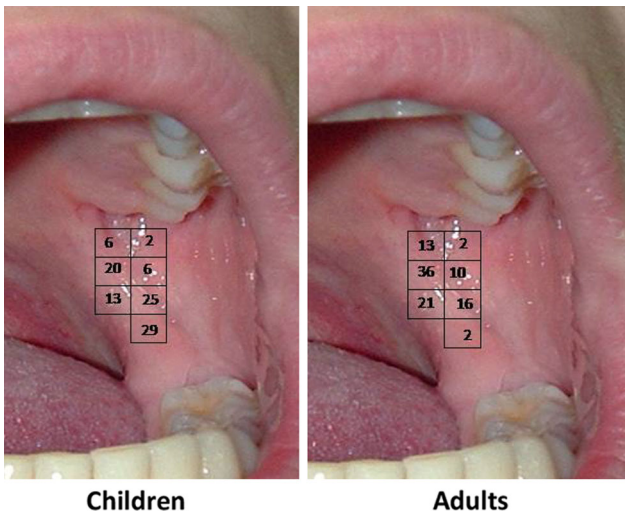


Fig. 4 Distribution of dentists (%) according to their reports of the location of the oral mucosa they penetrate in children and adults

Correlation between the target location of the injection on the ramus and successful anaesthesia in MBI

The distribution of dentists injecting the local analgesic solution in different locations on the mandibular ramus is presented in Fig. 5. Although most of the dentists who treat children and adults (57 and 78 %, respectively) target their injection to the area covered by the four central squares of the chart, about 25 % of the dentists who treat children target their injection more anteriorly. In adults, no correlation was found between the target location of injection on the ramus and reported successful anaesthesia ($N = 71$, $p = 0.42$). When treating children, a statistically significant lower success rate in achieving anaesthesia (only 1 carpule for achieving full anaesthesia in at least 90 % of their patients following MBI) was reported by dentists, who targeted their injection to the area covered by the two central (in superior inferior dimension) most anterior quarters in the chart (square numbers 8, 12; Fig. 5) versus dentists who target their injection to the area covered by the four central quarters (in superior inferior and anterior–posterior dimensions; square numbers 5, 6, 7, 9, 10, 11; Fig. 5), $p = 0.006$. The risk estimation for adding more carpules when injecting at the mid most anterior squares (8 and 12 square locations) is higher by 3.94 times than when injecting at 5, 6, 7, 9, 10, 11 (95 % confidence interval—ODD ratio = 1.248877–12.4142791).

Association between the length of needle insertion and reported success rate of MBI

All dentists, who treated children (80.2 % of the participants) reported inserting a short needle (26 mm) to a mean depth of 15.43 mm ± 4.5. A positive statistically significant correlation was found between the length of the inserted needle and self-reported achievement of full anaesthesia with MBI in 90 % or more patients ($p = 0.001$, $R = 0.356$). Hence, practitioners who used shorter needles more often needed to inject more than one carpule.

In treating adults, all the dentists reported inserting long needles (35 mm) to a mean depth of 28.9 mm ± 2.9 mm. No correlation was found in adults between the needle insertion length and self-reported achievement of full anaesthesia with MBI in 90 % or more patients.

The duration of routine waiting period from MBI administration to the start of operative treatment

When treating both children and adults, most dentists reported routine waiting period of 2–5 min before treatment (63.6 and 58.1 %, respectively). Dentists, who reported longer routine waiting periods in children tended to report using more carpules to achieve complete

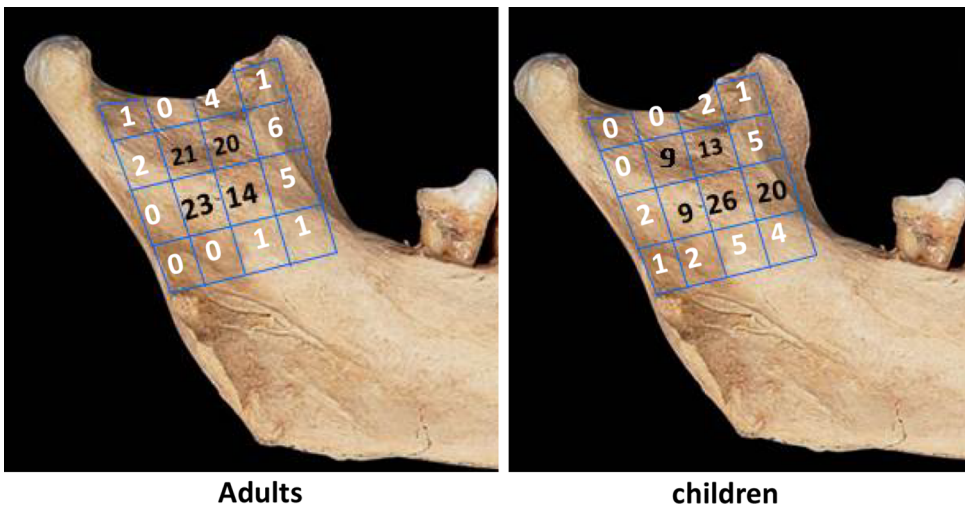


Fig. 5 Distribution of dentists (%) according to their reports of injecting to different locations of the mandibular ramus in children and adults

anaesthesia ($p = 0.042$, $\chi^2 = 6.335$). This trend was not reported for treatment of adults.

Certified paediatric dentists reported routine shorter waiting period from injection until the start of treatment than did general practitioners who treated children; however, this tendency did not reach statistical significance ($p = 0.085$).

Discussion

In this study, 20.5 and 42.1 % of dentists reported injecting more than one carpule in at least 11 % of their paediatric and adult patients, respectively, to achieve full anaesthesia in mandibular block injection. This compares with Malamed's (2004) recommendation to inject 0.89 % of a carpule for mandibular block anaesthesia (1.5 ml for mandibular block and 0.1 ml for lingual nerve anaesthesia).

The reported rates of successful anaesthesia in the present study are consistent with previous reports of a 63–87 % success rate (Kaufman et al. 1984; Childers et al. 1996). This reinforces the validity of the results reported herein.

The higher success rate reported in children may result from the decreased density of the mandibular bone, which permits more rapid and complete diffusion of the analgesic solution (Malamed 2004). Moreover, the more inferior location of the mandibular foramen in children facilitates transporting the analgesic solution into the mandibular foramen, by gravitation, even when the injection is performed more superiorly (Malamed 2004).

We found that in children, but not in adults, lower needle insertion lengths and targeting the injecting to the most anterior quarters of the ramus were positively correlated with failure of anaesthesia. The discrepancy in these findings between children and adults may relate to a greater variation of muscle and fat mass in adults than in children. This may result in greater difficulty in locating the target on the ramus, especially in overweight adults. Moreover, the standard deviation of the reported inserted needle length in children was higher than in adults (4.5 vs. 2.9 mm). This difference may in fact be greater, since the antero-posterior dimension of the ramus in children was shown to be shorter than that in adults by 9.53 mm: 22.48 vs. 32.01, respectively (Ashkenazi et al. 2011). Another factor that may contribute to these differences is that only 11 % of dentists treating adults targeted their injection to the area of the two central most anterior quarters, as compared to 25 % of the dentists treating children.

To compensate for an unsuccessful attempt at anaesthesia (defined as the use of more than one carpule), some clinicians increase the routine waiting period from completion of injection to the start of the operative treatment. According to the findings of the present study, extending the routine waiting period over 5 min did not increase the chance of achieving successful anaesthesia. Such a trend was found mainly in treating children. A possible explanation may lie in the fact that the bone of children is more spongious; consequently, most of the diffusion of the local analgesic solution to the mandibular bone occurs during the first 5 min.

The self-reporting design is a limitation of the present study. Further clinical studies should be conducted to affirm the relation between the length of the inserted needle and successful mandibular block anaesthesia in children and adults.

In conclusion, shorter lengths of needle insertion and targeting the injection to the central most anterior quarters of the ramus were positively correlated with unsuccessful anaesthesia in children. In adults, the needle insertion length was not correlated with successful anaesthesia. Routine waiting period of over 5 min was not associated with a greater rate of successful achievement of MBI in children.

Appendix

Questionnaire

Demographic questions: gender; age; years in practice; specialty (yes/no); type of specialty (paediatric dentistry, oral surgery), number of years in specialty.

Which population do you usually treat? (Children, adults, children and adults).

Please mark on the attached figure of the oral mucosa the location you usually penetrate to inject routine inferior alveolar block (mandibular block) in children.

Please mark on the attached figure of the oral mucosa the location you usually penetrate to inject mandibular block in adults.

Please mark on the attached figure of the mandibular ramus the location you usually direct your injection to, when you deliver routine inferior alveolar block (mandibular block) in children.

Please mark on the attached figure of the mandibular ramus the location you usually direct your injection when you deliver routine inferior alveolar block (mandibular block) in adults.

What is the needle length that you usually leave out of the oral mucosa during delivery of routine inferior alveolar block (mandibular block) injection in children? Please mark the needle length on the attached figure according to the length of needle you usually used (short or long).

What is the needle length that you usually leave out of the oral mucosa during delivery of routine inferior alveolar block (mandibular block) injection in adults? Please mark the needle length on the attached figure according to the length of needle you usually used (short or long).

How long (minutes) do you usually wait after completion of routine inferior alveolar block (mandibular block) injection and before starting the operative treatment in children? (A. 0–1 min, B. 2–5 min, C. 5–10 min, D. Over 10 min).

How long (minutes) do you usually wait after completion of routine inferior alveolar block (mandibular block) injection and before starting the operative treatment in adults? (A. 0–1 min, B. 2–5 min, C. 5–10 min, D. Over 10 min).

In what percentage of your child patients do you need to inject another carpule of local analgesic in order to achieve full analgesia (no complaint of pain)? A. 0–5 %, B. 6–10 %, C. 11–15 %, D. 16–20 %, E. 21–25 %, F. 26–40 %, G. Over 40 %.

In what percentage of your adult-patients do you need to inject another carpule of local analgesic to achieve full analgesia (no complaint of pain)? A. 0–5 %, B. 6–10 %, C. 11–15 %, D. 16–20 %, E. 21–25 %, F. 26–40 %, G. Over 40 %.

When your patients complain of pain, in what frequency do you attribute it to pressure?

A. 0–10 % of the cases, B. 10–25 % of the cases, C. Over 25 %.

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