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ORIGINAL RESEARCH

Anaesthetic efficacy of intraligamentary injection techniques on mandibular molars diagnosed with asymptomatic irreversible pulpitis: A retrospective study

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Abstract

The objective of this study was to evaluate the success rate of intraligamentary injections (ILI) using a two- or four-site injection technique. One hundred and fifty-one mandibular molars diagnosed with asymptomatic irreversible pulpitis received ILI at the mesiobuccal and distobuccal aspects of the roots. Patients who experienced pain when the access cavity was performed received additional supplemental ILI in the mesiolingual and distolingual aspects. Pulpal anaesthesia was considered successful when complete analgesia was achieved. The data were analysed by means of the Fisher's exact and Pearson's chi-square tests. IL anaesthesia was successful for 92.1% of the teeth. Forty-eight teeth (31.8%) were sufficiently anaesthetised using the two-site ILI and 91 teeth (60.3%) following supplemental IL anaesthesia in two more sites. The results of this study indicate that the use of four-site IL injections as a primary anaesthetic technique may be considered a favourable alternative to the common IANB.

Introduction

Local anaesthesia is the basis for successful dental treatment. Profound analgesia is required because ineffective analgesia may turn endodontic treatment into a traumatic experience. The inferior alveolar nerve block (IANB) is the most commonly used injection technique for achieving local anaesthesia of mandibular molars, although studies have shown failure rates of 44–81% (1–3). Even the use of supplementary injections or different carpule formulations failed to achieve high and predictable rates of mandibular molar anaesthesia (2,3). Therefore, as Claffey *et al.* (3) stated, it would be advantageous to improve the success rate of the IANB or find an alternative local anaesthesia technique that would be both efficient and predictable.

Intraligamentary (IL) injection is a technique that could be used as a supplementary injection in cases in which IANB is unsuccessful (2,4,5). The IL injection (a periodontal ligament injection) allows a local anaesthetic solution to be injected into the cancellous bone adjacent to the tooth to be anaesthetised (6). Earlier reports indicate a success rate of 50–96% for supplemental IL injections achieving pulpal anaesthesia in endodontic therapy (2,4,6–9).

In 1982, Malamed (7) suggested the use of IL injections as an alternative to the IANB. In single rooted teeth, he injected an anaesthetic solution into the mesial side of the gingival sulcus of the tooth to be treated. In cases of multirooted teeth, he added a second injection into the distal side of the sulcus. Malamed recommended additional buccal and lingual injections for periodontal and surgical procedures (7).

Tagger *et al.* (10) studied the spread of local anaesthetic solution administered using a pressure syringe. In their study, the spread of a solution injected at two sites was investigated in demineralised slices, three-dimensionally cleared specimens, and histological sections. The solution usually reached the alveolar crest, seeped under the periosteum, and entered the bone marrow spaces alongside vascular channels. The IL injection solution contained ink that spread along the least resistant path, influenced by the intricacies of anatomical structures and fascial planes, rather than penetrating the periodontal

ligament or the root canal. In the controls without a vasoconstrictor, the spread was more diffuse. Five days post-operatively, carbon particles from the ink were present only in macrophages (10). It is not clear, however, to what extent IL injections are successful when performed for endodontically involved molars and whether two points of injection are sufficient to achieve effective local anaesthesia.

The aim of this study was to evaluate the success rate of IL injections for root canal treatment of mandibular molars diagnosed with asymptomatic irreversible pulpitis using the two-site technique or, when needed, supplementary IL injections (i.e. the four-site technique).

Material and methods

This study was approved by the Ethics Committee in Research of the Rambam Medical Center (0393-14-RMB) and was conducted in accordance with the Declaration of Helsinki. The research was conducted according to Harmonized Tripartite Guidelines for Good Clinical Practice (ICH-GCP).

Inclusion criteria were defined as follows: All healthy (ASA I) adults older than 18 years of age referred to the endodontic clinic between 2011 and 2013 with a deep carious lesion in a mandibular molar and a clinical diagnosis of asymptomatic irreversible pulpitis (according to AAE Consensus Conference Recommended Diagnostic Terminology). The evaluations comprised a vitality cold test (EndoIce, Coltène/Whaledent Inc. Cuyahoga Falls, USA) and periapical radiographs.

Exclusion criteria included complaints of spontaneous pain, lingering pain or no response during cold tests, and teeth diagnosed with periodontal disease following probing and radiographic examination. In cases where supragingival calculus was noticed, the patient was scheduled for scaling prior to endodontic treatment. Teeth with radiographic findings of periapical radiolucency or widened periodontal ligament space were also excluded from the study.

The teeth were anaesthetised and treated by the same endodontic specialist (R.H) using the IL technique with an IL syringe (Ergoject Intralig Syringe, Anthogyr SAS, Sallanches, France), 30 gauge extra short needle (Septoject, Septodont Inc. Cedex, France) and 4% articaine hydrochloride with 1:100 000 epinephrine (3M GmbH, Neuss, Germany).

Anaesthesia protocol

- A 60-s mouth rinse with chlorhexidine gluconate 0.2% (MHRA PAR – Tarodent, Haifa, Israel) was performed.
- The IL technique is performed as follows: the needle was injected at approximately 30° to the long axis of the tooth at the mesiobuccal and the distobuccal aspect of the roots to maximum penetration, until it was wedged between the tooth and the crestal bone (11).
- Anaesthetic solution (0.2 mL) was injected at each location, and an access cavity was immediately initiated.
- Patients were instructed to report any experience of pain/discomfort during the access cavity preparation. If the patient felt any pain, supplemental IL anaesthesia was provided using the same cartridge at two different sites (the mesiolingual and distolingual aspects of the root), and the treatment was resumed.
- If the patient still felt pain/discomfort, an IANB was performed using a new cartridge and a 27-gauge-long needle (Septoject, Septodont Inc. Cedex, France) to complete the procedure comfortably.
- A rubber dam was placed following access cavity preparation to exclude stress or discomfort that might be interpreted as pain or discomfort.
- Patients were instructed to report any experience of dizziness or change in heart rate during the access cavity preparation.

To analyse the efficacy of this anaesthesia protocol, the procedures were divided into three groups according to the success or failure of the anaesthesia. The groups were defined as follows: Two-site successful anaesthesia was Group A, four-site successful anaesthesia was Group B and IL unsuccessful anaesthesia was Group C.

Statistical analysis was performed using SPSS for Windows, version 21 (IBM, SPSS, Chicago, IL, USA). Fisher's exact test and Pearson's chi-square test were used to determine differences between the overall success rates, particularly those between different molars. Significance was set at $P < 0.05$.

Results

One hundred and fifty-one mandibular molars in 151 patients were included in this study. Overall, IL anaesthesia was successful for 92.1% of the teeth and failed for 12 teeth (7.9%) requiring supplementary IANB. An analysis of the successful cases revealed that only 48 teeth (31.8%) were sufficiently anaesthetised using the two-site injection protocol (Group A). The remaining 91 teeth (60.3%) were sufficiently anaesthetised following supplemental IL anaesthesia in two more sites (Group B). The difference between the success rates of the groups was statistically significant ($P < 0.001$).

When statistical analysis was performed according to the molar location in the mandible, the failure cases were distributed as follows: seven cases were in the first molar and five cases were in the second molar. The success rate

in the first and second molars showed statistically favourable results when the four-site IL injection technique was performed, while statistically favourable results were obtained in the third molars when the two-site IL injection technique was used (Table 1).

No side effects, i.e. dizziness or change in heart rate, were noted during the access cavity preparation.

Discussion

Dower and Barniv (12) stated that the periodontal ligament (PDL) injection is primarily used when conventional anaesthesia is not fully effective, when dentists require only a short duration of anaesthesia, or when a patient wants to avoid the lip and tongue numbness associated with mandibular block injections. Success rates of intraligamentary anaesthetic injection techniques for mandibular molar teeth in this study are 92.1%. However, the success rates for inferior alveolar nerve block generally are 80–85%. (4,12). Lower success rates in the mandible could be a result of the greater density of the buccal alveolar plate (which prevents supraperiosteal infiltration in the case of IL injection), limited access to the inferior alveolar nerve and a wide variation in neuroanatomy in the case of IANB (13). Most previous investigations have used supplemental anaesthetic techniques in endodontic treatment only after failing to obtain successful anaesthesia following administration of an IANB (14–16). According to the findings of this study, IL injections succeeded for more than 90% of the cases of mandibular molars diagnosed with asymptomatic irreversible pulpitis, with no side effects or severe postoperative pain.

A meta-analysis by Shabazfar *et al.* (17) comparing IANB and IL injection anaesthesia in adult patients found no significant difference regarding failure rates and less injection pain in cases when IL injections were used. These findings are in accord with those of List *et al.* (18), D'Souza *et al.* (19), and Meechan (20), all of whom reported low pain ratings when IL was used as the primary injection technique. IL injection technique is safe to use, causing minor changes in the periodontium as shown by Walton and Garnick's (21) histological study.

Schleder *et al.* (22) reported a success rate of 86.7% and 20 min of profound pulpal anaesthesia when 2% lidocaine with 1:100 000 epinephrine was used for IL injections for asymptomatic mandibular posterior teeth. Post-injection discomfort was experienced by 88% of the subjects: 49% reported that their tooth felt high in occlusion, and only 5% reported severe pain on the day following the injection (22). Shabazfar *et al.* (17) also showed a latency period of >3 min for IANB, whereas the IL injection had nearly none. On the contrary, the effect of IANB was found to be longer than that of IL injections (17).

Various "injection diffusion" studies have shown the distribution of carbon particles and dyes in the periapex, medullary bone and pulp (9–11,23). As stated by Schleder *et al.* (22), these studies indicate that the IL technique is an intraosseous injection that involves the placement of the anaesthetic solution through the cribriform plate. In the present study, the two-site injection technique did not achieve sufficient and reliable anaesthesia. By adding two more sites, the four-site technique achieved an overall success of profound anaesthesia in over 90% of the cases. This significant difference occurred possibly due to the increased amount of anaesthetic solution or to the additional nerve fibres from the lingual aspect that were affected by the mesiolingual and distolingual IL injections. In the present study, we chose to use 4% articaine hydrochloride as it was found to provide better results in our previous work; nonetheless, further studies with other local anaesthetic agents are warranted (24).

The fact that third molars showed higher success rates in this study might be attributed to the shorter root length and to the fact that those teeth usually have less roots or a conic shape (C-shape) than first and second molars (25). Similarly, it can be assumed that

Table 1 Successful and failed IL injections by tooth type

		Successful IL injections			
	No. of teeth	Group A (two-site injection technique) (% of successful IL injections)	Group B (four-site injection technique) (% from total no. of teeth)	Group B (four-site injection technique) (% from unsuccessful two-site injection technique)	Failed IL injections (%)
First molar	70	14/70 (20.0)	49/70 (70.0)	49/56 (87.5)	7/70 (10.0)
Second molar	66	23/66 (34.8)	38/66 (57.6)	38/43 (88.4)	5/66 (7.6)
Third molar	15	11/15 (73.3)	4/15 (26.7)	4/4 (100)	0/15 (0.0)
Total	151	48/151 (31.8)	91/151 (60.3)	91/103 (88.3)	12/151 (7.9)

periodontally involved teeth that have less bone support will react in a similar manner and will have a better success rate in IL injection.

The present finding that IL is more successful than IANB is not surprising. It is difficult to achieve complete pulpal anaesthesia with IANB (2). As was pointed out by Malamed (26), the IANB remains the regional anaesthetic technique with the highest failure rate (2). IL can overcome failed conventional anaesthesia as shown by Walton and Abbott (6) and Smith *et al.* (9) or serve as a primary technique as shown in the present study.

The results of this study indicate that the use of the four-site IL injection as a primary anaesthetic technique should be considered a favourable alternative to the common IANB in asymptomatic mandibular molars. However, this is an assumption and further investigation seems warranted.

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