ORIGINAL RESEARCH

Predetermining the Quantity of Obturating Material in Primary Molars by Volumetric Analysis of Pulp Canal Space Using CBCT: An *In Vivo* Study

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Abstract

Aim: To predetermine the mass of obturating material required to obturate primary maxillary and mandibular first and second molars. To evaluate the obturation quality of primary mandibular second molar obturated using the predetermined obturation quantity.

Materials and methods: The formula mass = root canal volume × density was used to calculate the quantity of obturating material for each tooth. The average root canal volume was calculated using pre-existing cone-beam computed tomography (CBCT) scans ($n = 30$) of children aged between 4 and 9 years. Pulpectomy was performed in mandibular second molar and obturated with pre-determined quantity of obturating material. The quality of obturation was assessed in terms of over-obturation, under-obturation and optimal obturation.

Results: Optimal obturation was obtained in 43.3%, under-obturation was observed in 30% and over-obturation was observed in 26.7%

Conclusion: Obturating the primary root canals by predetermining the mass of obturating material will reduce the wastage of material (metapex) and cross-contamination of the material.

Keywords: Obturation, Predetermining quantity, Primary teeth, Pulpectomy, Pulp canal volume.

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Introduction

Pulpectomy is the most common endodontic treatment performed in primary teeth with irreversible pulpitis or necrotic pulp. The main objective of pulpectomy is to maintain the primary tooth in a functional state until the eruption of its successional teeth as it guides the permanent tooth to erupt in its position.[1] The word pulpectomy depicts the amputation of dental pulp followed by filling the root canals using a resorbable material.[2] An ideal obturation should be devoid of the gap between the obturating material. The material should be filled optimally up to the root canal length without gross over-extension or underfilling.[1,3] The prognosis of pulpectomy depends on the quality of obturating material as well as the technique of obturation.[3]

Metapex (Calcium hydroxide-iodoform mixture) has been extensively used as an obturating material in deciduous teeth due to its antibacterial and periapical healing properties. It is commercially available in a standardized premixed syringe with disposable tips. These premixed syringes pose numerous disadvantages which include wastage of material leading to increased expense, risk of over-obturation, and cross contamination.[3–9]

To overcome the above-mentioned drawbacks, a custom-made ampule with a predetermined quantity/grams of material for obturating a single tooth can be devised as an alternative technique for obturation.[6] To develop such a technique, we must know the average root canal volume of both primary anterior and posterior teeth is necessary to enable the calculation of quantity/grams of material required (mass = density × volume).[6]

Hence, the present *in vivo* study was conducted to estimate the volume of root canal in maxillary and mandibular primary molars using cone-beam computed tomography (CBCT) followed by obturation using a predetermined quantity/grams of obturating material in mandibular first and second molars.

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Materials and Methods

First, the parents/guardians were informed about the nature of the study and written informed consent was obtained from them. The ethical approval was obtained from the Institutional Ethics and Review Committee (Ref No: SSMC/DentIEC-9/JULY 2021). In this study, first, we determined the root canal space for maxillary and mandibular molars. The obturating material needed to obturate the root canals was calculated using the formula: Mass = Density × Volume. And then, we assessed the obturation quality (over-obturation, optima obturation and under-obturation) in primary mandibular second molar.

Table 1: Average root canal volume and the mass of required obturating material to obturate each tooth

Tooth number (FDI system)	*Mean root canal volume*
54	0.106 cm^3
55	0.122 cm^3
84	0.115 cm^3
85	0.143 cm^3

Table 2: The mass of obturating material (Metapex) used for obturation

Tooth number (FDI system)	*Mass*
54	0.22 gm
55	0.25 gm
84	0.24 gm
85	0.30 gm

Determining the Root Canal Space

Pre-existing CBCT scans showing maxillary and mandibular teeth of children aged between 4 and 9 years were used for calculating the average pulp volume in the root canals. A total of thirty CBCT scans without physiologic and pathologic root resorption were included in this study. The Planmeca Romexis 5.2.0.R software (Planmeca Oy, Helsinki, Finland) was used to calculate the average root canal volume of the selected teeth (deciduous maxillary and mandibular first and second molars). The pulp volume in root canals were measured as described in the previous study.[6]

The average root canal volume was given in Table 1.

Determining the Quantity of Obturating Material

The mass of obturating material required to obturate each tooth was determined using the formula:

Mass = Density × Volume.

Mass = Predetermined grams of obturating material to be calculated.

Density = Density of obturating material (for metapex it is 2.07 gm/cm^3)

Volume = Average root canal volume of primary mandibular second molar and canine (in cm^3) obtained using CBCT.

The mass of obturating material obtained using the above formula is given in Table 2.

Assessment of Obturation Quality

Sample Selection

A total of thirty primary mandibular second molar with irreversible pulpitis were selected from 4 to 9-year-old children visiting the Department of Pedodontics and Preventive Dentistry.

In this study, the participated children were selected based on the following inclusion Criteria (1) Co-operative children between 4 and 9 years of age. (2) Children with no history of any systemic diseases. (3) History of spontaneous pain, (4) Clinically non-vital tooth, (5) Continuous bleeding from the amputated pulp stump, (6) Radiographs showing deep dentinal caries involving pulp. The exclusion criteria were previously restored or fractured teeth, teeth with developmental anomalies, teeth with more than two-thirds of root resorption (internal or external) or pathologic resorption, unrestorable tooth, tooth with periapical pathology (periapical cyst, granuloma), calcification in canals, special children.

Table 3: Obturation quality

	Frequency	*Percent*
Underfilling	9	30.0
Optimal filling	13	43.3
Overfilling	8	26.7
Total	30	100.0

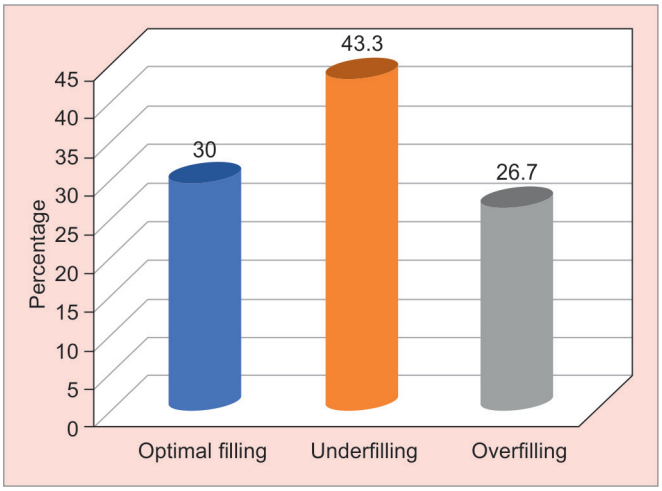

Fig. 1: Obturation quality

Pulpectomy Procedure

Single visit pulpectomy was performed under standardized treatment protocol for all the patients. After local anesthesia administration, access cavity was prepared using round bur. The coronal and radicular pulp was extirpated. Working length was kept 1 mm short of radiographic apex. Standard hand files were used for biomechanical preparation with subsequent irrigation using normal saline and 5.25% sodium hypochlorite. After biomechanical preparation, the root canals were dried using sterile absorbent paper points and the canals were obturated with predetermined quantity of Metapex using reamer technique and temporary restoration was placed.

After obturation, immediate postoperative radiograph was taken to assess the quality of obturation. The postoperative radiographs were assessed by two examiners and the scoring was given based on Coll's modification criteria.

- Underfilling (Score 1) – Canal filled more than 2 mm short of the apex.
- Optimal filling (Score 2) – Canal filling ending at the radiographic apex or up to 2 mm short of apex.
- Overfilling (Score 3) – Any canal showing filling outside the root apex.

Final restoration and stainless-steel crown placement were performed after a week. The average scoring of obturation quality is given in Table 3 and Figure 1.

Statistical Analysis

The data was collected, coded and fed in SPSS (IBM version 23) for statistical analysis. Percentage, mean and standard deviation were included for descriptive statistics.

Results

The mean root canal volume obtained was 0.22 gm for primary maxillary right first molar, 0.25 gm for primary maxillary right second molar, 0.24 gm for primary mandibular right first molar and 0.30 gm for primary mandibular right second molar (Table 1). The mean root canal volume obtained using the formula was 0.106 cm^3 for primary maxillary right first molar, 0.122 cm^3 for primary maxillary right second molar, 0.115 cm^3 for primary mandibular right first molar and 0.143 cm^3 for primary mandibular right second molar. Based on the obtained pre-determined mass of obturating material, the obturating quality was assessed as underobturation, overobturation and optimal obturation. 30% of mandibular primary molars were underobturated, 43.3% were optimally obturated and 26.7% were overfilled.

Discussion

Pulpectomy is one of the most common treatments for irreversible pulpitis in primary teeth. A successful pulpectomy can be achieved by eliminating the microorganisms in the root canals followed by obturating the root canals using antimicrobial material.[10]An ideal obturation should be devoid of voids and optimally filled in root canals throughout its length without overfilling/underfilling.[11]

The obturation technique plays an important role in achieving better obturation quality. There are numerous obturation techniques described in the literature. Few of the obturating techniques are incremental filling, navitip, disposable syringe, jiffy tube, insulin syringe, lentulospiral technique, pressure syringe, past inject, plugger, tuberculin syringe.[12] Overfilling and underfilling is the most unavoidable drawbacks reported with these techniques. Till now there are no ideal obturation technique is discovered.

Kalaskar et al.[6] suggested a custom-made ampule for each tooth with pre-determined quantity of obturating material. This ampule could reduce the errors in the quality of obturation such as over-obturation and under-obturation. The formula Mass × Volume is used to determine the quantity of obturating material required for obturating each tooth.

In this present study, we evaluated the volume of root canal spaces in the primary maxillary and mandibular first and second molars. We estimated the root canal volumes using the pre-existing CBCT scans as the CBCT scans are considered the most ideal, reliable most accurate method to evaluate root canal volume.[13] Volumetric analysis was performed using planmeca romexis software.

The root canal volume measurements can be used in forensic dentistry to estimate the dental age.[14] Studies estimating the root canal volume in primary dentition is less because of the continuous changes in canal volume in primary teeth due to physiologic resorption and the formation of secondary dentin.[13,14] This is the second clinical study on assessing the root canal volumes in primary teeth. The root canal volumes in our study were slightly greater than the volumes obtained in the previous study.

Further, we assessed the obturation quality when obturated using the pre-determined quantity of obturating material (metapex) in mandibular second molar. In our study, we assessed the quality of obturation using metapex by reamer obturation technique. Metapex is commercially available in a premixed paste in a syringe form. It is composed of calcium hydroxide, iodoform and silicon oil. The greater antimicrobial efficacy, faster resorption of the material if extruded beyond the apex, radio opacity makes the clinicians to use it commonly as an obturating material for primary teeth. Metapex obturation has demonstrated 100% success rate.[15]

Optimal obturation was obtained in 43.4% of primary mandibular molars. Obturation using the pre-determined obturating material also resulted in under-obturation and over-obturation. We took an intraoral periapical radiograph (IOPAR) when the operator assumed that the root canals are optimally obturated or when all the pre-determined mass of metapex was used. In this study, we did an additional step to prevent postoperative failure. We took the IOPAR before placing the final restoration to determine the obturation quality. After determining the obturation quality, if the primary molar is under obturated, additional metapex was used to obturate until the canals are optimally obturated. If the root canals were overfilled or optimally filled without using all the measured metapex, it was considered as overfilling.

The main disadvantage of this technique is the differences in root canal volume in different population, age, gender. The root canal volume and predetermining the quantity obturating material is difficult to calculate and conclude with one clinical study. Also, the primary teeth undergoes physiologic resorption. The rate of root resorption is different in each child and differs in each tooth. Many clinical trials have to be conducted to identify the ideal mass of obturating material for each primary tooth.

Conclusion

This study favors the invention of a newer obturating technique. Optimal obturation can be achieved by predetermining the quantity of obturating material in order to improve the quality of obturation in primary teeth.

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