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Assessment Of The Danger Zone Of Maxillary First Molar In An Indian Subpopulation: A Cone Beam Computed Tomography Evaluation

Swathi.S, Dr.S.Delphine Priscilla Antony, Pradeep Solete MDS,
[1,2,3,4] Department of conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical sciences, Saveetha University, Chennai-77.

Abstract: Introduction
Background:
Maxillary first molars have complex anatomy and strip perforation is most commonly seen due to extensive preparation of the internal dentinal wall, and therefore the most frequently fractured or extracted tooth. The aim of the study is to measure the dentin thickness of the mesial and distal walls of the cervical third in the maxillary first molars corresponding to danger zones respectively, using cone-beam computed tomography (CBCT).
Materials and Methods:
CBCT images of 577 maxillary first molars were analyzed in the Indian population. Measurements of dentin wall thickness were analyzed in the distal wall (danger zone) in the mesiobuccal canal of permanent maxillary first molars. The danger zone was assessed from furcal at every millimeter in the apical direction at five different levels using CS imaging software. The results were statistically analyzed using SPSS software.
Results:
The average dentin thickness of the danger zone was higher at the furcation level with 1.27mm and lowest at the 5mm level with a thickness of 0.96mm. The results were statistically significant ($p<0.05$).
Conclusion:
Within the limitation of the study, it may be concluded that the dentin thickness was higher at the furcal level and started decreasing gradually apical direction at 5 different levels.

Keywords: Danger zone; Mesiobccal canal; Dentin thickness; CBCT; Maxillary molar.

1. Introduction

In root canal therapy, the domain of internal anatomy of the teeth is critical for achieving disinfection. Proper location, cleaning, and shaping of the canals are paramount for success in endodontics [1]. The maxillary first molar (MFM) is one of the most often endodontically treated teeth and has the highest endodontic failure rate among posterior molars. [2] Because of its internal anatomic intricacy, it has been extensively studied by various methods [3].

During instrumentation, the maintenance of adequate root canal dentin thickness could prevent the inherent root fractures [4]. The MB root is often quite large buccolingually and has two root canals, MB1 and MB2, as well as a high incidence of fine anatomical features such as inter-canal connections, loops, accessory canals, and apical ramifications [3]. There are significant discrepancies in the literature regarding the root canal anatomy of the maxillary molars. Knowledge of the external and internal anatomical features of permanent teeth is vital as it directly correlates with the probability of success of root canal therapy . Consequently, it is very important to know the root canal anatomy if endodontic treatment is to be performed correctly.

Overzealous preparation of internal dentinal walls is most commonly seen with mesial roots of maxillary molars[5], [6]. Dentin thickness at furcation level is very less. Hence the thinnest portion of the root canal is considered as the danger zone [7]. The maxillary first molar is one of the most common teeth undergoing retreatment and having complex anatomy. The thicker dentin layer on the mesial aspect of the mesial root is minimally instrumented by rotary instruments which is termed as safe zone. [8].

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Despite the fact that there are many in vitro studies related to danger zone measurements in maxillary first molars widely, but very limited study on measuring the danger zone in the Indian population. Therefore, the aim of our study was to measure the thickness of dentin on the distal aspect corresponding to the danger zone in the mesiobuccal canal of the permanent maxillary first molars.

2. Materials and Methods:

The study protocol was approved by the institutional ethics committee. Written informed consents were obtained from all the patients.

Maxillary first molars were retrospectively analyzed in patients who underwent cbct scanning for diagnosis of facial trauma ,impacted teeth, orthodontic treatment, endodontic or implant treatment. The study protocol included the selection of teeth if their mesiobuccal roots met all the following criteria: (i) complete root formation with closed apex, (ii) intact pulp chamber, (iii) no signs of resorption or calcification, and (iv) absence of previous root canal treatment (v) age 20-50 years of age.

CBCT scanner used to scan the upper arches by an experienced radiologist. After the screening process, a total of 577 maxillary molars from 306 individuals were selected and assessed for the danger zone using cbct scans in the study. Power calculation was performed using G*Power 3.1 software for windows (Henrick Heine-Universitat, Dusseldorf, Germany) keeping an effect size of 0.1, alpha error of 0.05 and beta error of 0.95.

CBCT images evaluation:

CBCT images were assessed using CS imaging version 8 (carestream Dental India) by two experienced endodontists. Cohen's kappa statistics were done to check the reliability of the two examiners.

Measurements were done by placing the starting point at the level of furcation. The thickness of the dentinal wall was measured on the distal aspect of the mesiobuccal canal of the maxillary 1st molar, which was evaluated at every millimeter in the apical direction until the fifth millimeter [9]. The dentin thickness between the inner wall of the canal and the distal aspect of mesiobuccal canal was considered as danger zone and the dentin thickness on the mesial aspect of the mesiobuccal canal of maxillary 1st molar was considered as safer zone, measurements was done on axial plane of CBCT. All the measurements were performed using 4x magnification and the mean dentin thickness value was tabulated.

Statistical Analysis:

The mean thickness value obtained at five different levels which was statistically analyzed using SPSS software(version 23). Shapiro-Wilk test (mean and standard deviation) was used to analyse the normal distribution . Repeated measure ANOVA was used for pairwise comparison to compare the mean dentin thickness at five different levels. Bonferroni post-hoc tests were used if a significant difference was found. P value was less than 0.005 was considered as statistically significant.

3. Results:

The mean dentin thickness of the danger zone in the mesiobuccal root of the maxillary molar showed normal distribution. Measurements of dentin thickness on the maxillary 1st molar were evaluated from the furcal at every millimeter in the apical direction at five different levels for both danger zone and safer zone. The mean dentin thickness values of the danger zone were tabulated

Repeated measure ANOVA with Bonferroni post-hoc test was done which showed highly significant results between the pairwise comparison

Table 1: Mean ± standard deviation of the dentin thickness of the danger zone of the mesiobuccal canal of upper first molar at five different levels are tabulated.

ZONE	1mm	2mm	3mm	4mm	5mm
Danger zone	1.27±0.19	1.19±0.22	1.06±0.14	0.99±0.11	0.96±0.17

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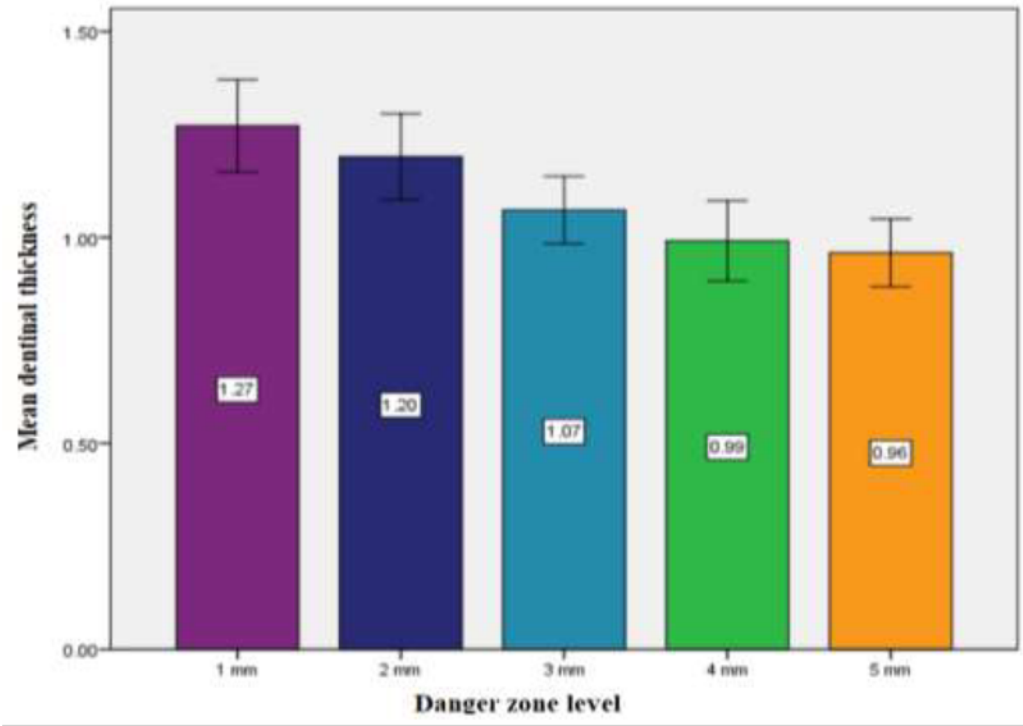
Figure 1: Error bars showing the mean dentin thickness of danger zone of mesiobuccal canal of maxillary first molar at five different levels



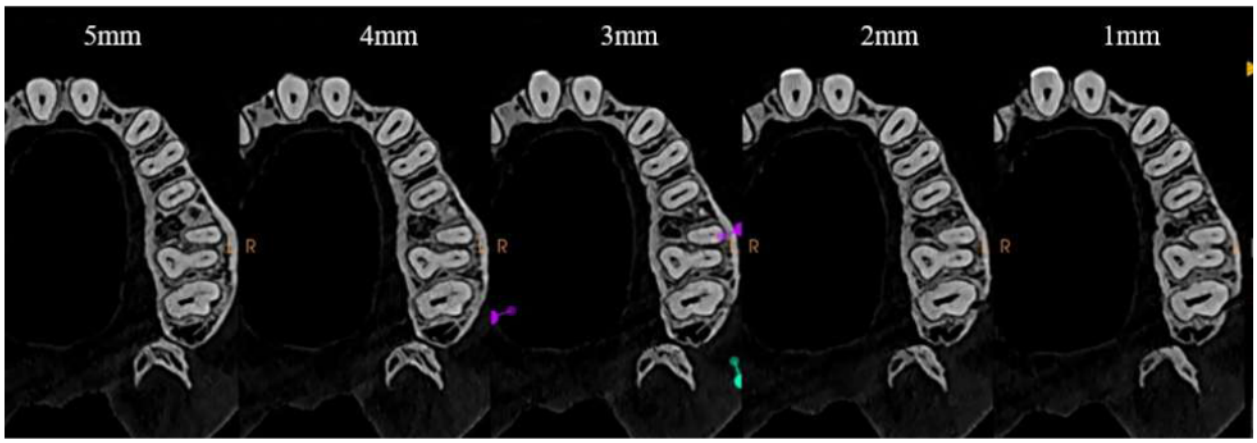


Figure 2 : levels assessed for measuring dentin thickness of danger zones at five different levels

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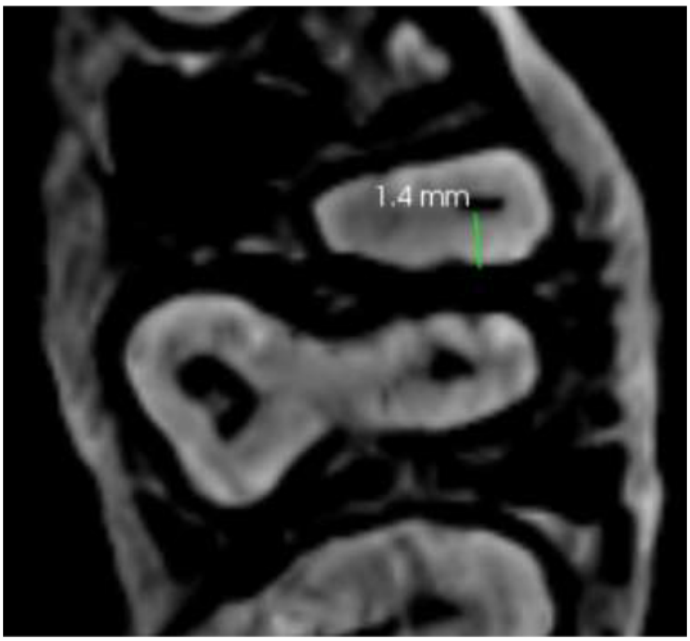

Figure 3: Danger zone measurements done in mesiobuccal root of maxillary first molar on axial view of cbct.

4. Discussion:

Thorough knowledge of the tooth anatomy is a important key factor affecting the treatment outcome more than the appropriate procedure for successful endodontic treatment[3], [10] .The root canal configuration systems proposed by Vertucci and Weine et al.[11], [12]have been extensively used. Degerness et al. (2010) stated that the distal surface of the mesiobuccal root of the maxillary first molar is a danger zone[13]

On comparing the values between the canal transportation and centring ability that do not display differences in dentin removal. Excessive instrumentation remove more dentin and could be noticed only if we take into account formulas proposed by Gambill *et al.* [14]. Lim et al stated that remaining dentin thickness should not be less than less than 0.3mm to withstand the forces during normal tooth function. Thickness of the furcal wall is preserved and risk of perforation is reduced using anticurvature filing and the result was statistically significant;[15]Morfis et al. reported that excessive dentin removal increased the risk of vertical root fracture and minimum residual dentin thickness was reversely correlated with the odds of tooth fracture. The results of their study also revealed that excessive dentin removal increased the risk of vertical root fracture[16], [17]

[18] compared the accuracy of CBCT and steromicroscope in measuring dentin thickness of the danger zone and found no significant difference between these two methods. Accordingly, CBCT can be a technique with high accuracy for measuring the dentin wall thickness in the danger zone and was confirmed by Flores et al. [19]. CBCT gives low dose of radiation when compared to other radiograhic methods this provides the images with high-quality spatial resolution in a short time of acquisition and multiple possibilities of virtual assessment of maxillary regions in a rate of 1:1 [20]. Green et al[21] found the average distance from the apex to be 0.4 mm in the MB root of maxillary molars and stated that the CBCT x-ray beam is heterochromatic and has lower mean kilovolt (peak) energy compared with conventional CT[20]. Hűbscher et al., evaluated the volume and surface area changes and also stated that micro ct was used for canal shape analysis of maxillary molars to compare pre and post-operative geometrical changes in prepared canals[12]

The present study provided the distal wall (danger zone) thickness of the mesiobuccal canal of maxillary first molar in the Indian population. In our opinion this is the first study used cbct for assessing the danger zone area in indian population .The main limitation of the study is MB 2 canals was not considered in to account and the safe zone area was not measured in both MB 1 canals, small sample size was considered in to account, future study must include the MB 2 canals and also measure the safer zone with larger population must also be included.

5. Conclusion:

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Within the limitation of the study, it could be concluded that dentin thickness in the mesiobuccal canal of the maxillary first molar has higher thickness in the furcation area and decreased towards the apical direction at five levels. These data gives the importance of maintaining the remaining dentin thickness in the root canal to avoid strip perforation or fracture of the root canals.

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