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ORIGINAL RESEARCH

Evaluation of Root canal morphology of maxillary first premolar by clearing technique in Kashmiri population: An in-vitro study

Shabir Ahmad Bhat[1], Mushtaq Mohammad Bhat[2], Ab. Wahid Zargar[3]

[1]Dental surgeon at District Hospital Kulgam, Jammu and Kashmir, [2,3]Postgraduate Student, Department of Conservative Dentistry & Endodontics, Govt. Dental College and Hospital Shireen Bagh, Srinagar, India

***ABSTRACT*:**
Aim: The aim of this study was to determine the root form and canal configuration in maxillary first premolars. **Materials and Methods**: 200 extracted human adult maxillary first premolar teeth from kashmiri population were collected. Access cavities were prepared and the coronal pulp tissue was extirpated. The samples were stored in 5% nitric acid solution for 5 days. They were then rinsed, dried, and dehydrated using increasing concentrations of ethanol (70, 80, and 95%) successively for 1 day. Teeth were rendered transparent by immersing in methyl salicylate. India ink was then injected. The root canal morphology was examined under stereomicroscope. **Result**: 53% were single rooted followed by fused root form followed by two root form. Variable root canal configurations were also found. Type IV configuration was most prevalent (32.5%). Two teeth showed an additional configuration. Lateral canals were present in 36% of the samples and intercanal communications in 20%. **Conclusion**: Within the limitations of this study, it was concluded that in kashmiri population, there was an increased propensity for types IV, I, II, and III canal morphologies in maxillary first premolars. Single root form was most common.
Key words: Canal morphology; clearing technique; dehydration; demineralization; methyl Salicylate; nitric acid.

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Corresponding author: Dr. Shabir Ahmad Bhat, Dental surgeon at District Hospital Kulgam, Jammu and Kashmir

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INTRODUCTION

Any attempt to perform endodontic therapy must be preceded with a thorough understanding of the anatomy of both the pulp chamber and the root canal system.[1] The risk of missing anatomy during root canal treatment is high because of the complexity of the root canal system[2] and may lead to endodontic failure. A thorough knowledge of root canal morphology is essential for successful endodontic therapy.[3,4] Numerous factors contribute to the variations found in root canal studies including ethnicity,[5] age,[6] gender,[7] and study design.[8 The maxillary first premolars are among the most difficult teeth to be treated endodontically due to their variation in number of roots, canal configuration, the direction and longitudinal depressions of the roots, and various pulp cavity configurations[9]. Different methods have been used to investigate tooth morphology like tooth decalcification and dye injection, sectioning of the teeth and radiographic studies *in vitro*,[12] alternative radiographic techniques,[13] and radiographic assessment enhanced with contrast media.[14] Current
literature shows that where atypical anatomy is suspected, modern radiographic techniques like spiral computed tomography and micro-computed tomography are highly helpful in making a proper diagnosis as they offer noninvasive reproducible techniques for three-dimensional

assessment of root canal system.[15,16] Despite their accuracy, these modern radiographic techniques involve expensive equipment. In the present study, clearing technique was used.[17] It enabled viewing of a three dimensional
morphology of roots and canals without altering the internal shape of pulp cavity or direction of the canals. This procedure was chosen for our study as it is relatively simple, inexpensive, and acceptable. It also has a low incidence of error.[9] Information on the root and canal morphology of maxillary first premolar teeth from populations of indigenous Indians is scarce and till date there is no published data on root canal morphology of kashmiri maxillary first premolars; therefore, the aim and purpose of this study is to assess root form and canal morphology of maxillary first premolars in a kashmiri population by using clearing technique.

MATERIALS AND METHODS

The material consisted of 200 extracted maxillary first premolar teeth. They were collected from the department of oral and maxillofacial surgery government dental college srinaga. The teeth were collected with the verbal consent of the patients. However, the age and sex of the patients who donated the teeth were not recorded. Hard and soft deposits were removed
from the tooth surfaces using hand scaling instruments, and the teeth were scrubbed in running cold tap water. The teeth with less than two-thirds of the crown present, which could not easily be differentiated based on crown morphology as described by Scott and Symons [18] were excluded. The remaining 200 specimens were made transparent following the method of Yang, et al.[19] with modifications. An endodontic access cavity was prepared in each specimen using a high-speed handpiece and diamond fissure bur. The specimens were placed in a 5% sodium hypochlorite solution (Ameya Chemicals, Mumbai, India) and periodically agitated for 24 h to dissolve the organic tissue from the root surface and the root canal system. They were then washed in running water for 2 h, dried on a wire mesh, and decalcified in 5% nitric acid (MJ Patterson, Dunstable, UK) for 6 days. The nitric acid solution was changed daily and manually agitated once a day during the first 3 days. However, during the last 3 days the acid solution was not changed. The teeth were rinsed in running cold tap water for 4 h and dried on a wire mesh. They were dehydrated in successive solutions of 75% and 95% alcohol; each for 12 h. Transparency was induced by placing the specimens in 99% methyl salicylate (Merck, Poole, UK). To clearly view the root canal system, India ink (Calder Colours, Ashby-de-la-Zouch, Leicester, UK) was coronally injected into the pulp chambers using a 5 ml plastic disposable syringe with a 23 gauge needle (Sherwood Medical, St. Louis, MO, USA). The ink was withdrawn through the root apical foramen/foramina using a rubber tube with one end inserted up to the cervical third of the root and the other end connected to a suction machine (Ramvac, Spear-fish, SD, USA). After the ink had dried, root canal morphology was examined under stereomicrosope (Olympus; zoom type).

The following observations were made:

1. Number of roots,

Group I: One root form.
Group II: Two root form.
Group III: Fused root form.
Group IV: Three root form.

2. Type of root canals,
3. Presence and location of lateral canals and intercanal communications,
4. Location of apical foramina The canal configuration will be categorized into the eight
types of Vertucci's classification (1984) as follows:

- Type 1: A single canal present from the pulp chamber to the apex;
- Type 2: Two separate canals leave the pulp chamber and join short of the apex to form one canal;
- Type 3: One canal leaves the pulp chamber, divides into two within the root, and then merges to exit in one canal;
- Type 4: Two separate and distinct canals are present from the pulp chamber to the apex;
- Type 5: Single canal leaves the pulp chamber, but divides into two separate canals with two separate apical foramina;
- Type 6: Two separate canals leave the pulp chamber, but join at the midpoint and divides again into two separate apical foramina;
- Type 7: One canal leaves the pulp chamber, divides and rejoins within the canal, and finally redivides into two distinct canals short of the apex; and
- Type 8: Three separate distinct canals extent from the pulp chamber to the apex.

RESULTS

After studying the morphology of 200 maxillary first premolars, it was found that 53% were single rooted followed by fused root form (27.5%); followed by two root form in 19% samples. Only 0.5% had three rooted maxillary first premolar. Type IV configuration was most prevalent (32.5%), followed by type I (26%), type II (15%), type III (14%), type V (4%), type VII (3.5%), type VI (1.5%), and type VIII (0.5%). Six teeth showed an additional configuration; Sert and Bayirli's type XIX (2-1-2-1) and another exhibited Sert and Bayirli's type XIII (1-2-1-3). Lateral canals were present in 36% of the samples; cervical third (7%)> middle third (11%)> apicall third (18%). Intercanal communications were present in 20% of the samples; middle third (10%)> apical third (8%)> cervical third (2%). Out of all the canals; canals exiting in single foramina were 45%; whereas, 54% exited in two separate foramen. Only in 1%, three apical foramen were present.

Root Canal morphology, root form, lateral canals and intercanal communications

Vertucci's canal morphology	Number 200
Type I	52 (26%)
TypeII	30 (15%)
Type III	28 (14%)
Type IV	65 (32.5%)
Type V	8 (4%)
Type VI	3 (1.5%)
Type VI	7 (3.5%)
Type VIII	1 (.5%)
Sert and Bayirli type XIII	4 (2%)
Sert andBayirli type XIX	2 (1%)
Root form	Number
Group 1	106 (53%)
Group 2	38 (19%)
Group 3	55 (27.5%)
Group 4	1 (.5%)
Lateral canals	Cervical third 14 (7%) Middle third 22 (11%) Apical third 36 (18%) Total 72 (36%)
Intercanal communications	Cervical third 4 (2%) Middle third 20 (10%) Apical third 16 (8%) Total 40 (20%)

Location of apical foramen

Central exit	Lateral exit
Single canal at the apex: 90	12
Two Canals at the apex: 108	10
three Canals at the apex: 2	0

DISCUSSION

Different methods have been employed in studying the root and canal morphology of the different teeth. Recently, spiral computed tomography [20] and micro-computed tomography [21] have been advocated for use in studying root and canal system. Although these methods are very accurate, but involve expensive equipment. In the present study, a modified clearing method was used. It enabled viewing of a three-dimensional morphology of the roots and canals[22]. It is relatively simple, acceptable and inexpensive procedure. It also provides a three-dimensional view of the canal.The inorganic constituents of the tooth are first dissolved by decalcification; water, air, and lipid components are removed by dehydration; and by subsequent immersion in the clearing agents.[23] nitric acid (5%) used as a decalcifying agent is rapid in its action,it causes little damage to the tissue if the time of decalcification is controlled rapidly. After fixation in aqueous solutions, tooth tissue needs to be dehydrated slowly in order to prevent high degree of shrinkage due to the rapid removal of water. Then the dehydrating agent is replaced by methyl salicylate, which renders the tooth transparent as the clearing agent increases the refractive index of the tooth.[23,24] In this study, the use of stereomicroscope for viewing the root canal pattern resulted in higher magnification. The maxillary first premolars are among the most difficult teeth to be treated endodontically due to their variation in number of roots, canal configuration, the direction and longitudinal depressions of the roots, and various pulp cavity configurations; [9] therefore, maxillary first premolars were chosen for the study.

Single roots, two roots, and three roots have been identified in maxillary first premolars, with the number of canals ranging from one to three per root.[12] The number and morphology of roots of Indian first premolars differ from those of Mongoloid first premolars, in which three roots are reported to be rare.[10] Though only a small percentage of the number of teeth studied were three rooted, it is important to consider this variation in the clinical scenario.

The literature suggests that the occurrence of three canals in these teeth may vary from 0.5 to 7.5%.[12] Vertucci[27] reported that maxillary first premolar was the only tooth which had all the eight types of canal configurations. This was in accordance with our study in which all eight types of canal configurations as well as two rare Sert and Bayirli's canal configurations (types XIII and XIX) were also found.

In the present study, 53% of the first maxillary premolars had one root; similar to Brazilian population where the reported incidence was 55.8%.[9] Prevalence of 19% of two rooted samples was recorded in the present study, which is lower than values observed in other populations.[10] The differences between the results of these morphology studies may be related to variations of examination

methods, classification systems, sample sizes, and ethnic background of tooth sources.[16] in the current study We found 32.5% of all the samples had Vertucci's type IV canal configuration followed by Vertucci's type I canal configuration (26%). This was in accordance with Vertucci's study, where type IV canal configuration was most common in maxillary first premolars.

The present study also showed occurrence of lateral canals and was found to be 36% with maximum number noted in the apical third. (18%) This was in accordance with text book of endodontics, where maximum incidence of lateral canals was in the apical third of the root.[25] This variance rarely, if ever, causes an endodontic failure. When they harbor inflamed and/or infected material, they may cause pain during endodontic treatment. They may simulate periodontal disease and may cause problems with

treatment if present when a tooth is left open for drainage. Periodontal disease may cause pulp exposure via lateral canals located coronally.[26]

Intercanal communications or transverse anastomoses/ were also found in the present study and was present in 20% of the samples with maximum being in the middle third. (10%) This was in accordance with textbook of endodontics, where maximum incidence intercanal communication was in the middle third of the root.[25] An isthmus is a narrow, ribbon-shaped communication between two root canals that contains pulp or pulpally derived tissue. It functions as a bacterial reservoir.[26] Literature has reported a high percentage of intercanal communications in teeth with two canals. This communication is of clinical significance as it may be difficult to debride and fill it adequately.[26] The location of apical foramen is of clinical significance during working length determination, which often depends on the average position of the apical constriction relative to the root apex.[26]

CONCLUSION

The maxillary first premolar teeth in this Kashmiri population showed a higher prevalence of two-root morphology with the majority of the roots having a Vertucci type IV canal configuration and multiple apical foramina. There was .5% three root anomaly recorded in the present study.

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