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Incidence of Radix Entomolaris in the Indian Population - An In-vitro and In-vivo Analysis

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Abstract:
Aim: To determine the incidence of Radix Entomolaris in the Indian population using Conventional radiographs, Radiovisiography and Spiral CT.
Materials and Methods: A clinical and radiographic prospective evaluation was made for permanent mandibular first molars (750) scheduled for root canal treatment (including both primary endodontic treatment and retreatment). 300 extracted permanent mandibular first molars were collected to be investigated in the laboratory. Conventional and Digitalized radiography (Radiovisiography) was used for human patients. Spiral CT was used to study the morphology of extracted teeth.
Results: Radix Entomolaris was found in 9% of the teeth examined.
Conclusion: The high frequency of an extra root in mandibular first molars makes it essential to anticipate and find all canals during primary endodontic treatment and retreatment.
Keywords: Anatomical variations, Mandibular first molar, radix entomolaris, Three-rooted molar.

Introduction

The morphological knowledge of root canals is indispensable and improves the operator's ability to locate and trace a root canal to its termination, thereby increasing the degree of successful treatment.[1-3] The permanent mandibular first molar is usually two-rooted, a mesial and a distal. The major variant

in this tooth type is the presence of an additional third root; a supernumerary root which can be found lingually. This macrostructure, which was first mentioned in the literature by Carabelli[4], is called Radix entomolaris (RE).[5] The third root of the permanent mandibular first molar has been described by various terms, such as distolingual root, additional or extra distolingual root and radix entomolaris. [8,9] The permanent mandibular first molar is the earliest permanent posterior tooth to erupt, responsible for development of occlusion and important physiologic functions like chewing. Commonly, it is the most frequently in need of endodontic treatment.[6,7] Thus, it is of utmost importance that the clinician be familiar with variations in the root and root canal anatomy of the mandibular first molar.

Tratman[8] surveyed the incidence of Radix Entomolaris in the Indians (asian) in 1938, since then no other study has been done to determine the incidence of Radix Entomolaris in the Indian population. With the advent of better diagnostic aids like digitalized radiography and spiral CT, the occurrence of Radix Entomolaris is easily detectable. The present study highlights the incidence and the importance for the neeed for proper diagnosis in order to anticipate and find all canals during molar root canal treatment to facilitate the endodontic procedure and avoid missed canals thus preventing failure of the treatment.

Incidence

Incidence of Radix Entomolaris in the mandibular first permanent molar.[9]

In European populations: 3.4–4.2%.[1,10-13]

African populations (Bantu, Bushmen, Senegalese): 3% is found.[1,15,16]

Eurasian and Indian populations: less than 5%.[8]

Chinese, Eskimo and American Indians (Mongoloid traits) : 5% - 40%.[8,11,13,17-29]

Classification of Root Canal Anatomy:

Based on the external root morphology and scouting of root canals, Radix Entomolaris could be classified in three groups (Figure1). This classification is based on a classification proposed by Ribeiro & Consolaro. [34]

• Type I refers to a straight root/root canal.

• Type II refers to an initially curved entrance and the continuation as a straight root/root canals.

• Type III refers to an initial curve in the coronal third of the root canal and a second buccally orientated curve starting from the middle to apical third.

Materials and Methods:

Laboratory Analysis: 300 extracted first mandibular permanent molars from the Western Indian population were collected from various private dental clinics in Udaipur city during year 2010 to be investigated in the laboratory. Those teeth having a third root, distolingual root, were detected using clinical examination. To evaluate the internal morphology of Radix entomolaris, Spiral CT was done on a single tooth with confirmed Radix entomolaris. The teeth with three roots were isolated and their percentage was computed. The record included only the incidence of occurrence of Radix Entomolaris.The major limitation of the study being the inability to acquire radiographs directly from rural regions of West India.

Clinical Observation:

A clinical and digitalized radiographic prospective evaluation was made for first mandibular permanent molars, scheduled for root canal treatment (including both for primary endodontic treatment and retreatment). This study involved 750 patients (438 male and 312 female subjects), whose ages ranged from 20 to 45 years. Those teeth having a third root, distolingual root, were detected using digital radiographic examination and Spiral Computed Tomography. Two preoperative digital radiographic images were recorded (Schick Technologies,Inc, NY and Dr.Suni Plus, Suni Medical Imaging Systems Inc.,USA). The first with conventional angulation and the second with a mesial shift of approximately 20°), to allow better visualization of the buccolingual anatomy.

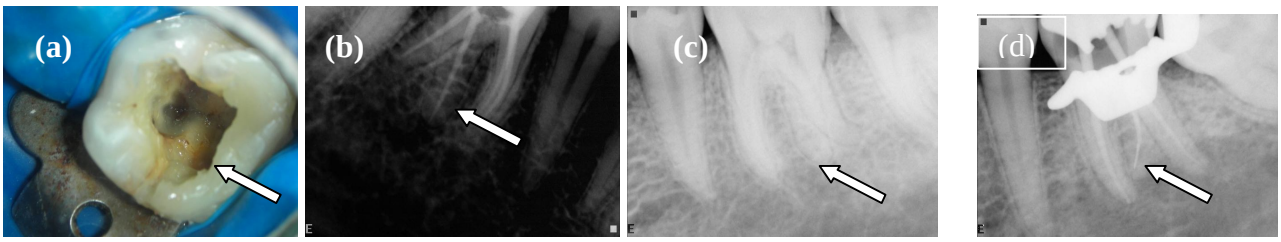

Figure 1(a)- Access opening modified for RE in mandibular molar; (b-d)-Radiographs showing RE(arrow).

Figure 2-An additional/extra disto-lingual cusp in permanent mandibular first molar

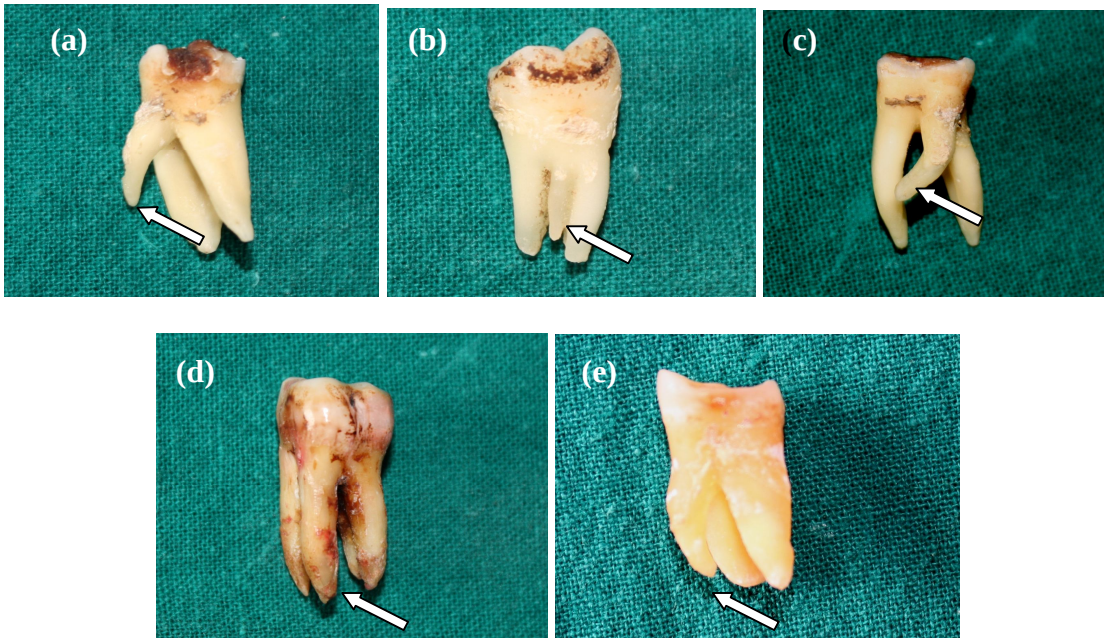

Figure 3(a-e): Extracted First Permanent mandibular molars showing RE.

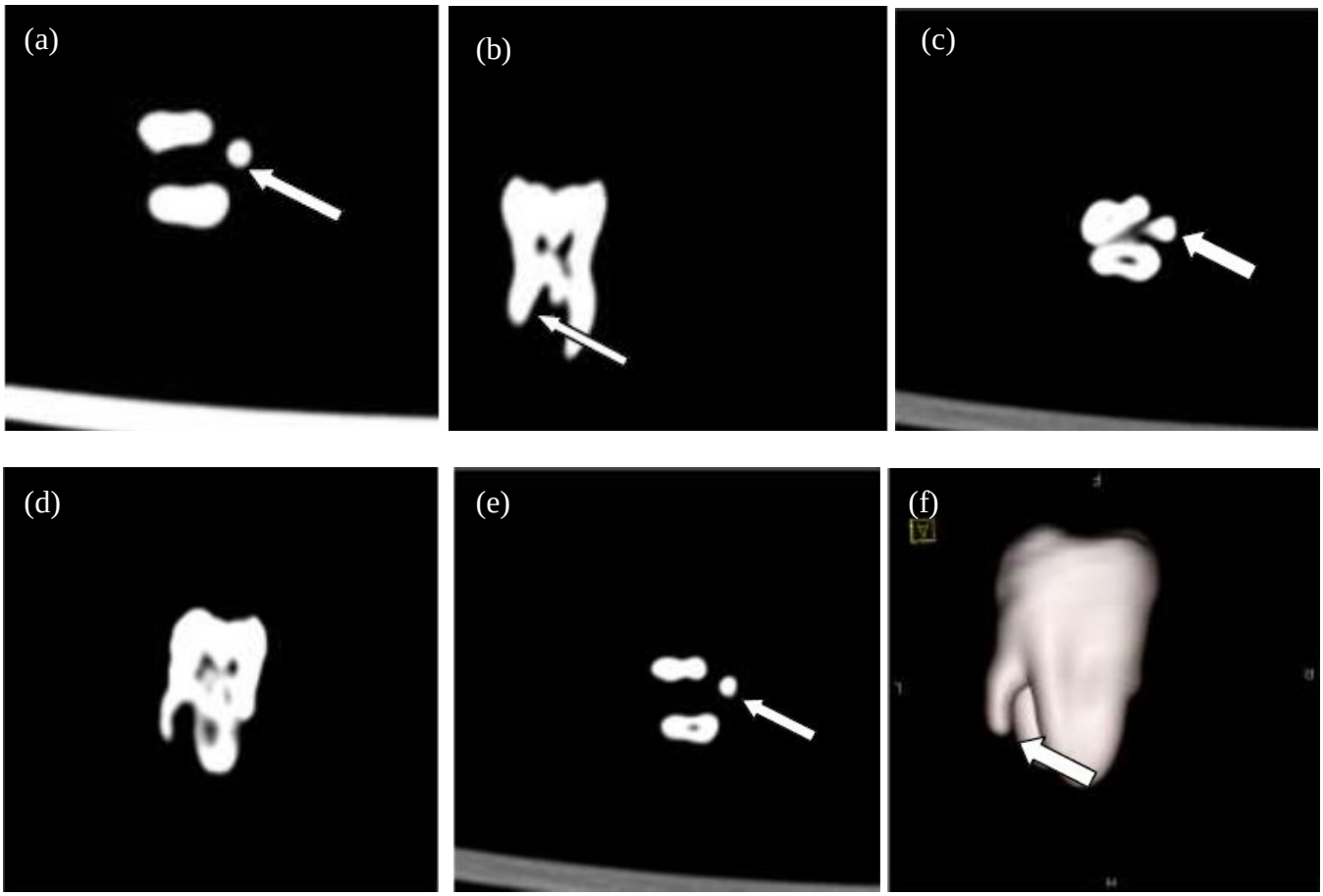

Figure 4(a-f): Spiral CT's showing RE.

Table 1- Prevalence of three-rooted mandibular first molars – survey of available studies

Year of study	Country Origin	Total number of teeth evaluated	Number of teeth with three roots	Percentage of total (%)
Taylor -1899[10]	United Kingdom	119	4	3.4
Bolk -1915[5]	Netherlands	1713	18	1.0
Drennan - 1929(14)	South African Bushman	23	0	0.0
Shaw -1931[15]	African Bantu	68	0	0.0
Tratman -1938[8]	Chinese	1615	95	5.8
	Malay	475	41	8.6
	Javanese	110	12	10.9
	Indians	453	1	0.2

	Eurasians	262	11	4.2
	Japanese	168	2	1.2
Laband-1941[17]	Malay in N. Borneo	134	11	8.2
Pedersen-1949[18] Greenland	Eskimo	64	8	12.5
Somogyl-Csizmazia & Simons - 1971[20]	Canadian Indians	250	39	16.0
De Souza-De Freitas et al.-1971[11]	European	422	27	3.2
	Japanese	233	83	17.8
Skidmore & Bjorndahl -1971[1]	Caucasian	45	1	2.2
Turner -1971[21]	Aleut Eskimo	263	84	32.0
	American Indian	1983	116	5.8
Curzon & Curzon -1971[19]	Keewatin Eskimo	98	28	27.0
Curzon -1973[12]	United Kingdom	377	13	3.4
Curzon -1974 [22]	Baffin Eskimo	69	15	21.7
Vertucci & Williams-1974[7]	Not stated	100	0	0.0
Hochtstetter - 1975 [23]	Guam	400	52	13.0
Jones-1980 [24]	Chinese	52	7	13.4
	Malaysian	149	25	16.0
Reichart & Metah 1981[25]	Thai	364	70	19.0
Walker &	Hong Kong	213	31	14.6

Quackenbush -1985 [26]	Chinese			
Steelman-1998 [30]	Hispanic children	156	5	3.2
Walker -1988[27]	Hong Kong Chinese	100	15	15.0
Loh 1990 [31]	Chinese (Singapore)	304	24	7.9
Younes et al. -1990 [32]	Saudi	581	17	2.92
	Egyptian	739	6	0.01
Ferraz & Pe´ cora -1992[13]	Japanese	105	12	11.4
	Negroid	106	3	2.8
	Caucasian	117	5	4.2
Yew & Chan-1993 [28]	Chinese	832	179	21.5
Sperber & Moreau-1998[16]	Senegalese	480	15	3.0
Gulabivala et al-2001 [29]	Burmese	139	14	10.1
Rashid & Suliman-2006[3]	Iraqi	1483	121	8.1
Song et al2009 [33]	Korean	1304	431	33.1

Table 2: Distribution of Radix Entomolaris in permanent mandibular first molars

Additional root	Occurrence (n=1050)		Bilateral occurrence (n=750)	
	N	%	N	%
Present	97	9.2	37	4.4
Absent	953	90.8	717	95.6
Total	1050	100	750	100

Table 3: Incidence of Radix Entomolaris in permanent mandibular first molar according to gender (n=750)

Additional root	Males n (%)	Females n (%)	P
No	388 (88.6%)	291 (93.3%)	0.032*
Yes	50 (11.4%)	21 (6.7%)	
Total	438 (100 %)	312 (100%)	

*P <0 .05, chi-square test.

Table 4: Incidence of Radix Entomolaris in permanent mandibular first molar according to side. (Topological significance) (n=750)

Additional root	Right n (%)	Left n (%)	P
No	389 (94.4%)	290 (85.8%)	0.000*
Yes	23 (5.6%)	48 (14.2%)	
Total	412 (100%)	338 (100%)	

*P <0 .05, chi-square test.

An additional root: An independent and clearly discernible root adjacent to the distal root was counted as an Radix entomolaris (additional root), a criteria concurrent with other studies.[9,21, 35-37.] An additional root was radiographically justified by the crossing of the translucent lines defining the pulp space and the periodontal ligaments.

Access Preparation: The conventional triangular access cavity was modified into a more trapezoidal cavity in order to locate and open the orifice of the distolingually.

Radiographic evaluation and statistical analysis:

The radiographs were randomly divided into 4 groups, and each group was examined by a different endodontist. Kappa values were calculated to quantify the interexaminer reliability. The incidences of an additional root were calculated for permanent mandibular first molar, gender, and side. Statistically significant differences with gender and side were evaluated using the chi-square test with Statistical Package for the Social Sciences (SPSS Version 11) software, with significance set at P less than 0.05. The incidences of bilateral occurrence were calculated.

Results:

Upon clinical and laboratory observation of a total of 1050 permanent mandibular first molars, 97(9.2%) exhibited radix entomolaris, 73 clinical cases and 24 extracted teeth. The incidence of bilateral occurrence was 52%. The incidences of radix entomolaris were higher in males than in females (P <0.05). Topological predilection for the presence of radix entomolaris in the first permanent molar is more on the left side in this study (P <0.05). Kappa values for the Radix entomolaris 0.87, indicating a good interexaminer reliability.

Discussion:

When Radix Entomolaris is present, the additional root in a mandibular molar is located distolingually, below the cervical border of the tooth. Seldom is the distolingual supernumerary root equal in size (length or diameter) to the distal root, and it is cross-sectionally more circular than the distal root, projected lingually about 45° to the long axis of the tooth [21] and has a type I canal system. [38-41] The additional root is not simply a division of the distal root, but rather is a true extra root with a separate orifice and apex.[39] The distal root of a two-rooted mandibular first molar usually has two distinguishable minor apices with one, two or more apical foramina. But, the distal root of a

three-rooted specimen has frequently one apex, as does the super numerary distolingual root. Multiple foramina may occur in the former. It appears that three-rooted molars result as a consequence of strong bifurcation and lingual displacement of the distolingual root element during its growth. There seems little reason to doubt that the third root is a lingually-displaced portion of the distal root, and there is never any doubt as to whether a tooth is two- or three-rooted.

When a radix entomolaris is present in the permanent mandibular first molar, the primary molars anterior to it often also present with an extra distolingual root, either only in the second primary molar or both in the first and second primary molars.[33] This relationship among molar teeth is consistent with the incidence of radix entomolaris, being highest in the first permanent molar and lowest in the first primary molar, and can be explained by Field developmental theory. [21,42,43]

According to the Field developmental theory [42], key teeth exist for the anterior and posterior fields of the jaws i.e. canine for the anterior teeth and the first permanent molar for the posterior teeth. Teeth that are more distant from a key tooth exhibit fewer characteristics of the field that they belong to.[42] The first permanent molar is the main site for field-affecting genes.[21] Therefore, it can be conjectured that the formation of an additional root is controlled by certain field-affecting genes that are transcribed mainly in the first permanent molar area and often in primary molars, which has been described as the mesial part of the molar field.[21]

In the present study, an incidence of 9.2% was observed, it was also observed in the extracted teeth that the extra distal root was not simply a division of the distolingual root; rather it was a true extra root.Three-rooted mandibular first molars are evidently a discontinuous trait as far as occurrence is concerned; however, they vary continuously with respect to size and form. Earlier, the normal mandibular molar was considered to have two-roots; the occurrence of three-roots was so common among Asiatics that it must be considered for them normal and characteristic, not an atavism or strange anomaly. A supernumerary distolingual root also occurs infrequently on the deciduous first and second molars.[33] In the Chinese, Malays, Javanese, Asiatic Indians, and Eurasians, the supernumerary root occurs four to eight times more often on the permanent first molar than on the deciduous second, suggesting that it is the permanent first molar which is the major site for a field-affecting gene.[8]

In the present study a bilateral occurrence of 52% has been observed. Bilateral occurrence of an additional root in the first permanent molar has been observed in previous studies in about 50% to 68% of cases.[21,26,30,31,33,37,40] Some studies have also reported a Unilateral pattern of occurrence.[44]

A gender predilection for males over females was seen(P <0.05) for radix entomolaris in this study, this observation is consistent with several other studies.[3,11,20,21,30,33] However, several other studies reported that the prevalence of radix entomolaris was similar in both the sexes.[3,31,33] A few studies have reported a female predilection over males.[37]

Topological predilection for the left side was seen in this study, this observation is concurrent with several studies.[31,39] However, several others have reported a right side predilection. [8,30,33,37,44]

Identification of Radix entomolaris can be done by clinical inspection of the tooth crown and analysis of the cervical morphology of the roots by means of periodontal probing explorer, path finder, DG 16 probe and micro-opener, Champagne effect- bubbles produced by remaining pulp tissue in the canal, while using sodium hypochlorite in pulp chamber.[9] An extra lingual cusp or more prominent occlusal distal or distolingual lobe(Fig.3), in combination with a cervical prominence or convexity maybe indicative of Radix entomolaris; however an increased number of cusps is not necessarily

related to an increased number of roots; however, an additional root is nearly always associated with an increased number of cusps, and with an increased number of root canals. [36]

With the advent of newer radiographic modalities like radiovisiography and spiral CT, detection of radix entomolaris is easier. Although a spiral CT is a 3-dimensional modality, but it is an expensive and an inconvenient modality and can be used occasionally for study purposes only. Moreover it is not appropriate to subject the patient to high doses of radiation of Spiral CT for endodontic diagnostic purposes. Hence conventional and digitalized radiography should suffice for the diagnosis of Radix entomolaris. Conventional radiographs like digitalized radiography are 2-dimensional but they provide less accurate information and subject the patient to a higher radiation dosage. In the present study, the variations in distal root anatomy were identified through careful reading of angled radiovisiographs, the first radiovisiograph was taken with conventional angulation and the second with a mesial shift of approximately 20°. This buccal object rule has also been called SLOB rule (same lingual, opposite buccal)/Clark's rule/Walton's projection.[45] The additional root appears as a shadow or a thin radiolucent line in the radiographs. In order to confirm the location of this additional root. An H-file can be placed in it and a K-file was introduced into the distal canal before taking the radiograph.

Ideally, a thorough radiographic examination of the involved tooth with exposure from three different horizontal projections, the standard buccal-to-lingual projection, 20˚ from the mesial, and 20˚ from the distal reveals the basic information regarding the anatomy of the tooth in order to perform endodontic treatment.[45] However, using the buccal object rule with two radiographs with different horizontal angulation is sufficient to determine the position of a lingual root. One of these radiographs is taken in the orthoradial position and the other taken at either 30˚ mesially or distally.

Most previous studies related to the occurrence of radix entomolaris have used 2-dimensional modalities like conventional radiographs only, none of them have used digitalized radiograhs or 3-dimensional modalities like spiral CT to investigate the morphology of radix entomolaris. The present study highlights and gives an insight to the increase in prevalence of Radix Entomolaris in the western Indian population using newer diagnostic modalities along with conventional radiographs.

Thus knowledge of the location of additional roots and its root canal orifices, adapted clinical approach, avoids or overcomes procedural errors during endodontic therapy and reduces incidence of retreatment.

Conclusion:

The high prevalence of Radix Entomolaris in the Indian population must be considered normal and characteristic, not an atavism or strange anomaly. Thus the high frequency of a fourth canal in mandibular first molars makes it essential to anticipate and find all canals during molar root canal treatment in order to facilitate the endodontic procedure and avoid missed canals. Proper angulation and interpretation of radiographs help to identify the chamber and root anatomy. In the case of radix entomolaris the conventional triangular shaped access cavity must be modified to a trapezoidal form in order to better locate and access the distolingually located orifice of the additional root. Straight-line access, in this respect, has to be emphasized, as the majority of the radix entomolaris are curved. Knowledge of both normal and abnormal anatomy of the molars dictates the parameters for execution of root canal therapy and can directly affect the probability of success.

Therefore, practitioners must be familiar with all molar variations, as well as their prevalence in the Indian population. Further

extensive research is warranted to detect the incidence of Radix entomolaris in the complete Indian population.

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