

A clinical study on the incidence of 'C' shaped root canals in mandibular second molars in patients visiting the department of conservative dentistry and endodontics, G.D.C, Bangalore

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ABSTRACT

Aim: The purpose of this study was to determine the incidence of clinically and radiographically recognized C-shaped canal systems in mandibular second molars treated in the Department of Conservative Dentistry and Endodontics at the Government Dental College and Research Institute, Bangalore during 2008-2009 in a sample representing a Bangalore population., **Methods:** 100 patients were selected randomly requiring root canal treatment of mandibular second molar over a 1-year period. The incidence of C-shaped canals was revealed following radiographic and clinical examination. Two pre-operative radiographs were taken using the shift cone technique and clinical investigation was conducted by scrutinizing the pulp chamber and canal entrance following access., **Results:** C-shaped canals occurred more frequently below 40 years; females had a greater (5.7%) predilection than males (1.9%); single rooted teeth (4%) more than two rooted teeth (1%). A total of 5 C-shaped canals were recognized clinically and 12 by radiographic method. Out of the 12, only 3 canals were confirmed clinically. The proportion of C-shaped teeth detected by radiographic method was significantly lower than the proportion of clinically diagnosed cases., **Conclusion:** 5% exhibited a C-shaped canal configuration and clinical method was more efficient in diagnosis of this canal variation than the radiographic method.

Keywords: mandibular second molar, canal configuration, C-shaped canal.

INTRODUCTION

Of all the teeth in human dentition, mandibular second molar has the widest variation of canal configuration. The most common finding is two separate roots, with two canals in the mesial root and one canal in the distal but many other combinations are possible¹.

One of the most important anatomic variations is the "C" configuration of the canal system.

The C-shaped canal, which was first documented in endodontic literature by Cooke and Cox in 1979, is so named for the cross sectional morphology of the root and root canal. Instead of having several discrete orifices, the pulp chamber of the C-shaped canal is a single ribbon shaped orifice with 180° arc, which, in mandibular molar starts, starts at the mesiolingual line angle and sweeps around the buccal to the end at the distal aspect of pulp chamber. Fortunately, C-shaped canals with a single swath of canal are an exception rather than the rule².

Once recognized, the C-shaped canal provides a challenge with respect to

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debridement and obturation, especially because it is unclear whether the C-shaped orifice found on the floor of the pulp chamber actually continues to the apical third of the root^{2, 3}.

Endodontic textbooks state that the C-shaped canal is not uncommon and this is confirmed by studies in which frequencies ranging from 2.7-8% have been reported. Investigations of the root canal anatomy of mandibular second molars conducted on Japanese, Chinese and Hong Kong Chinese populations showed a high incidence of C-shaped canals (31.5%).

It has thus been established that this particular anatomy is more frequent in Asians than in any other racial groups³

However, this variation has not been documented in an Indian population. Hence this study was undertaken to provide information on the distribution of C-shaped canal anatomy and determine its frequency in Indian patients.

MATERIAS AND METHODS

This study was conducted in accordance with all the local regulations after obtaining ethical clearance.

Among the patients visiting the Department of Conservative Dentistry and Endodontics, Government Dental College, Bangalore with the complain of decay or pain in the lower back tooth region, 100 patients were selected randomly.

After obtaining the informed consent from the patients who accepted the proposed root canal treatment, selected teeth were scheduled for radiographic and clinical examination.

Patient's thorough history was taken and careful clinical examination, pre-operative radiographic examination were performed.

Two preoperative radiographs were taken at a constant target film distance and angulation: one with a 90 degree angulation to the tooth in a buccolingual direction and

the other at a mesial and distal angulation of approximately 20 degrees using shift cone technique to allow better visualization of the buccolingual anatomy.

Clinical examination was carried out after adequate anaesthesia wherever required and rubber dam isolation, carious dentin was removed using arotor hand piece with copious irrigation and suction of all necrotic debris to avoid transportation of necrotic tissue and bacteria in the apical direction.

Access cavity was prepared using access cavity preparation kit.

Root canals were explored with size 10k files: radiographs were taken with the file within the canal to confirm canal morphology. Teeth were identified as having a 'C' shaped canal morphology based on the following classification (Melton *et al.* 1991).

1. Category I: continuous C shaped canal running from the pulp chamber to the apex.
2. Category II: 'semicolon' (;) shaped orifice in which dentine separated a main C shaped canal from one mesial distinct canal
4. Category III: subdivision I, C shaped orifice in the coronal third that divided into two or more discrete canals that joined apically; subdivision II, C shaped orifice in the coronal third that divided into two or more discrete and separate canals in the missed root of the apex; and subdivision III, C shaped orifice that divided into two or more discrete and separate canals in the coronal third to the apex.

METHOD OF STATISTICAL ANALYSIS

The statistical analysis aimed at comparing the effectiveness of radiographic method against that of clinical method.

McNemar's statistic for dependant proportions was used to test for statistical significance at 0.05 level.

The null hypothesis was that the two methods give the same results and thus detect

the C-shape identically. The alternate hypothesis was that the radiography method doesn't give the same result as clinical method

and hence is inept in detecting presence of C-shaped canal.

Table I: Number of cases and roots in the mandibular second molars and C-shaped canals

Number of roots	No. of samples	Number of canals				C-shaped
		1	2	3	4	
One rooted	27	1	-	26	-	1 (3.7%)
Two rooted	71	-	-	49	22	4 (5.6%)
Three rooted	2	-	-	2	-	-
Total	100	1	-	77	22	5 (5%)

RESULTS

The results of the present study with respect to the age, gender predilection, number of canals and roots in the mandibular second molars and C-shaped canals, and the number of C-shaped canal identified by each diagnostic method are featured in table I-III.

Out of 100 mandibular second molar, 71 were two rooted (71%) and 27 were one rooted (27%) and 2 (2%) were three rooted.

Out of the 27 one rooted mandibular second molars, 1 had one canal (3.7%) and 26 had three canals (96.2%).

Out of 73 two rooted mandibular molars, 51 had three canals (69.9%) and 22 had four canals (30.1%),

Amongst the various age groups, it was seen

that more number of C-shaped canals were seen in the age group 18-40years (4) than above 40years (1). Younger age group showed one type I, one type II, and two type III canals and older age group showed the presence of one type III canal.,

Amongst the 54 males, only one exhibited C-shaped canal (2%) while 4 of the 46 (9%) females exhibited C-shaped canal.

Out of 100 mandibular second molar, 71 were two rooted (71%) and 27 were one rooted (27%) and 2 (2%) were three rooted. (Table I, graph I)

The total incidence of C-shaped canals in this study was 5 out of 100 (5%); 4 teeth had two root and 1 tooth had one root (Table II, graph

Table II: Incidence of C-shaped mandibular second molars out of 100 teeth

No. of roots	Number of C-shaped canals	Type I	Type II	Type III		
				Sub I	Sub II	Sub III
One rooted	1	-	-	-	-	1
Two rooted	4	1	1	2	-	-
Three rooted	0	-	-	-	-	-
Total	5	1	1	2	-	1

II), 77 teeth (77%) had three canals, 22 teeth (22%) had four canals and 1% had one canal. The total incidence of C-shaped canals in this

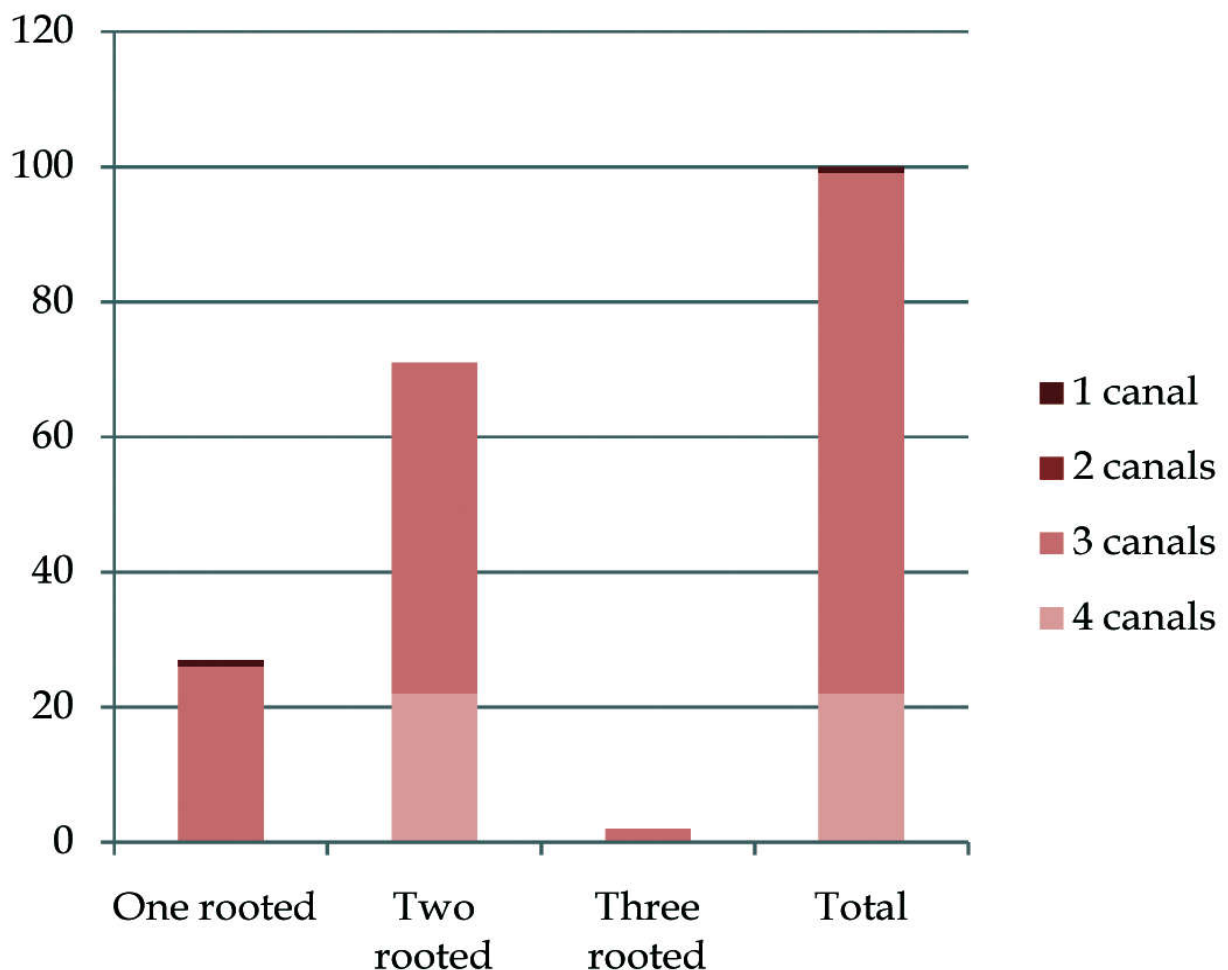
study was 5 out of 100 (5%); 4 teeth had two root and 1 tooth had one root.

Table III: Number of C-shaped canals recognized radiographically and clinically

		Clinical diagnosis	
		Non C-shaped	C-shaped
Radiographic diagnosis	Non C-shaped	83	2
	C-shaped	12	3
Total		95	5

A total of 5 C-shaped canals were recognized clinically and 12 by radiographic method. Out of the 12, only 3 canals were confirmed clinically.

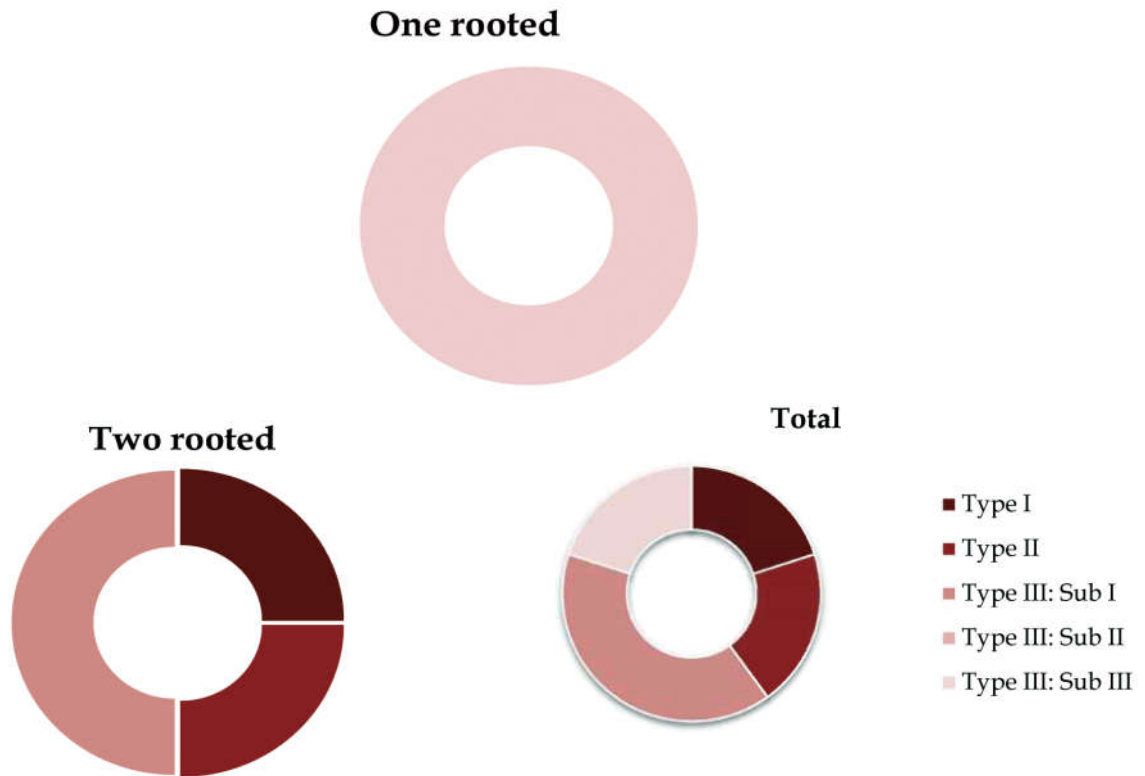
Graph I: Number of cases and roots in the mandibular second molars and C-shaped canals



According to Melton's classification, one molar presented a continuous C-shaped canal (category I) and one had a semicolon shape (category II) with a mesial canal located on

the lingual side and fusion of the distal and mesio buccal canal on the buccal side. The remaining three were considered as category

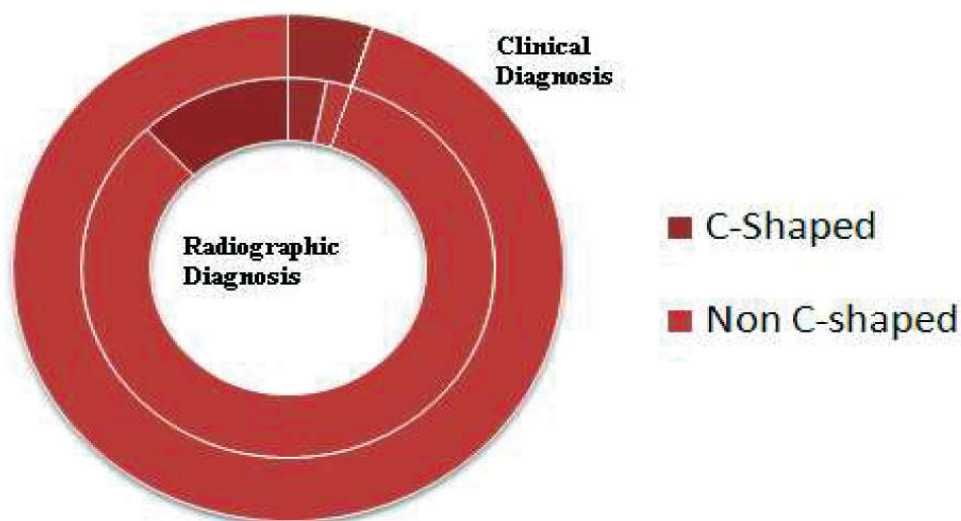
Graph II: Pie diagram showing the incidence of C-shaped canals in 100 teeth



III amongst those: two were subdivision I; one was subdivision III.

The results of the radiographic method in relation to those obtained clinically are illustrated in table III, graph III.

Graph III: Comparison of the number of C-shaped recognized clinically and radiographically



Based on the p value (0.0007), there was evidence that the proportion of C-shaped teeth detected by radiographic method was significantly lower than the proportion of clinically diagnosed cases (P less than 0.05).

From the following results it was observed that C-shaped canals occurred more frequently below 40 years with more chances of exhibiting a true C-shaped canal with females having a greater (9%) predilection than males (2%). The prevalence of C-shaped mandibular molars in this study was greater in two rooted teeth (4%) than single rooted teeth (1%).

DISCUSSION

C-shaped canal is one of the most difficult situations with which the dentist is confronted during endodontic treatment of teeth. It was first described by Keith (1908), and later by Keith and Knowles (1913), Pedersen (1949), Tratmen (1950), and Cooke and Cox (1979)⁴. Studies on the morphology of the root canal system have demonstrated the complexity in number and distribution of canals in mandibular molars.

Differences may be due to dissimilarities of examination methods, classification systems, sample size and ethnic background of the tooth sources⁵.

Cooke and Cox claimed that 8% of the mandibular second molars treated endodontically at Washington university school of dentistry in late 1970 have had the C-shape, although no total sample size was indicated⁶.

Tamse and kaffe, in 1981, investigated the incidence of conical mandibular second molar, as opposed to those teeth with two separate roots, using a radiographic study. They reported that 9% of 1049 mandibular second molars were conical, but did not comment on the possibility of the C shape⁷.

In 1972, Pineda and Kuttler investigated 7275 roots radiographically, including 300 mandibular second molars, but reported no C shapes and, in fact, no single rooted mandibular second molars⁸.

In the present study, the incidence of C-shaped canals in mandibular second molars was detected based on radiographic and clinical examination.

Teeth with C shaped canal systems were categorized by using the classification by Melton⁹.

This study also elaborated by on the gender and age related occurrence of this canal configuration.

Previously reported differences in the root canal anatomy of mandibular second molars may be owing to the population from which teeth were chosen.

If a Caucasian population were studied, then predominantly two rooted mandibular second molars could be expected (Ainamo&Loe1968, Tamse&Kafe 1981, Vertucci 1984, Weine et a. 1998), whereas if Asian or Mongoloid population were examined, a higher number of teeth would be single rooted (Kotoku 1985, Walker1988). The present study showed a greater number of two rooted mandibular second molars (71) than single rooted ones (27) corresponding to the results of Weine et al. (96%)

Cooke and Cox⁶ stated that it was impossible to diagnose C-shaped canals on the preoperative radiograph.

This was partly the case in the present study as interpretation of preoperative radiographs identified fewer cases than the contribution of the combined preoperative and working length radiographs in the diagnosis of C-shaped cases.

This, however, does not imply that early radiographic information is of no value. Clinically it remains the only non invasive method available, and by strictly

adhering to the radiographic criteria for determining the incidence of C-shaped canals in the mandibular second molars, the findings of this study were in good accord with those of other recent studies using various techniques.

In this study almost all preoperative radiographs showed common characteristics that provided a typical image and allowed identification of this anatomic condition. In fact, most radiographs revealed radicular fusion or proximity, a large distal canal, a narrow mesial canal, and a blurred image of a middle third canal.

According to our clinical records of the 100 second molars treated, 5 were C-shaped, a percentage of approximately 5%.

A total of 12 cases were identified as C-shaped by the radiographic method of which only 3 were confirmed by clinical diagnosis and the remaining 9 were considered 'false positive'.

The other two were diagnosed clinically which had not been recognized radiographically ('false negative')

This is approximately half of that indicated by the clinical records of mandibular second molars treated at the Washington University School of Dental Medicine⁶; where 8% had C configuration, also, less than 44.6% reported by Jin et al.¹⁰, 31.5% reported by Yang et al.¹¹, 32.7% reported by Seo and Park¹², and 19.14% reported by Haddad et al.¹³.

The percentage found in the present study is also approximately double the 2.7% found *in vitro* by Weine et al¹⁴. The dependence of tooth morphology on ethnic background is probably the explanation of the discrepancy between the findings of this study and the others.

Future studies may reveal interesting information about the canal configuration and incidence of C-shaped canals in mandibular second molars in different ethnic populations.

In the present study only one molar presented a continuous C shaped canal (category I), one with a semicolon shaped orifice with canals converging at the apex (category II), remaining three were considered as category III, amongst those two were subdivision I; and the remaining one was subdivision III which was in agreement with the study by Manning¹⁵.

Of all the patients exhibiting category III, two were below 40 years of age and one was above 40 years. This is partly in agreement to the observation of Manning¹⁵ that age related deposition of dentin formed separate canals. Also, this configuration occurred with a greater frequency in females below 40 years of age. This could be attributed to the genetic variations as prevalent among the cases in Bangalore city.

According to the literature, the main reason for failure in endodontic treatment of mandibular second molars is the inability to detect the presence of C-shaped canals prior to endodontic therapy.

The presence of high incidence of transverse anastomoses, lateral canals and apical deltas make it difficult to clean and seal the root canal system in these teeth¹⁶.

The results of the present study demonstrate that mandibular second molar teeth have many variations in the number of roots and the morphology of the canals therefore; it cannot be assumed that mandibular second molars always have two roots and three canals.

The great differences evident among studies with regard to the anatomy of mandibular second molars and the incidence of C-shaped canals may be attributable to racial differences and study methods and that radiographic method alone is not accurate enough to reveal its true incidence.

However, by strictly adhering to the radiographic criteria for determining the incidence of C-shaped canals in the

Tooth number 47

Figure 1: Pre-operative radiograph



Figure 2: Accessopening with C-shaped orifice



Figure 3: Working length radiograph

mandibular second molars and confirming it by clinical diagnosis, the findings of this study were in good accord with those of the other recent studies using various techniques.

However, further investigation is needed for a better understanding of C-shaped canal distribution in mandibular second molars.

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