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RESEARCH ARTICLE

DIAGNOSTIC ACCURACY OF CONE BEAM COMPUTED TOMOGRAPHY IN VISUALIZING MANDIBULAR RETROMOLAR CANAL: A RETROSPECTIVE STUDY

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ABSTRACT

Introduction: The retromolar canal normally arises from the mandibular canal behind the third molar, and travels antero-superiorly to the retromolar foramen (RMF), which is located within or around the retromolar triangle. RMF permits the passage of vascular-nerve bundles that contribute to nutrition and innervation of the pulp and periodontium of mandibular molar teeth. The aim of the present study was to assess the presence of retromolar canal along with diameter and course using CBCT as it offers advantages in terms of better visualization of the structural images of the anatomical variation with high contrast. **Materials and methods:** The present study was conducted in 100 individuals within the age group of 18 to 50 yrs with erupted or impacted mandibular third molar was included in the study for the presence of RMC using CBCT. Axial, sagittal, and cross-sectional images were reconstructed for all hemi-mandibles. The retromolar canals were classified into 9 categories. **Results:** The present study comprised of CBCT images of 100 subjects in which 43% were males while 57% were females, ranging from 18-50 years with a mean of 23.5±7.6. Of 100 CBCT images, retromolar canal was found in 18 subjects (18%) whereas a total of 25 RMCs (11 left, 14 right) were detected. Both male (50%) and female (50%) have equal prevalence of RMC and the age group 21-30 years (38.9%) tended to have more RMC than the other age group. **Conclusion:** Age, gender and location had no significant association with the course and diameter of RMC. The knowledge of this anatomical variation is important for surgeons to prevent damage to the nerves arising from retromolar canal.

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INTRODUCTION

The retromolar canal (RMC) is an anatomic variation of mandibular canal found in the retromolar triangle (Sisman *et al*., 2015). The retromolar canal normally arises from the mandibular canal behind the third molar, and travels antero-superiorly to the retromolar foramen (RMF), which is located within or around the retromolar triangle (Park *et al*., 2016). RMF permits the passage of vascular-nerve bundles that contribute to nutrition and innervation of the pulp and periodontium of mandibular molar teeth (Rossi *et al*., 2012). The neurovascular content of the RMC has been evaluated in cadaver and in clinical biopsy specimen which showed thin nerve fascicles of myelinated nerve fibers branching from the inferior alveolar nerve, small arteries, and numerous venules accompanying those arteries. Damage to the retromolar canal nerves and vessels could potentially lead to unexpected bleeding and paresthesia (Rossi *et al*., 2012). Thus, a thorough understanding of the possibilities of the presence of anatomical variations of the RMC are fundamental in surgical procedures like orthognathic surgery, mandibular reconstruction, extraction of third molars and implant placement (Rossi *et al*., 2012; Sekerci *et al*., 2013). Ossenberg suggested that the prevalence of the retromolar canal varies according to ethnicity and stated that retromolar canal are more common in native populations of North America than in other parts of the world such as India, Europe, Africa, and Northeast Asia (Ossenberg, 1987). Sisman *et al*. (2015) reported that the prevalence rate of retromolar canal in conventional two-dimensional (2D) radiograph is 3.06% in comparison to cone beam computed tomography (CBCT) which accounts for 26.7%. (Sisman *et al*., 2015). CBCT offers advantages in terms of better visualization of the structural images of the anatomical variation with high contrast. Till date, not many studies have been conducted on the anatomical variations of RMC. The aim of the present study was to assess the presence of retromolar canal along with diameter and course using CBCT.

MATERIALS AND METHODS

The present study was conducted in 100 individuals for the presence of RMC using CBCT. The CBCT scans were obtained from a radiological diagnostic centre which was taken using the 9300 Care Xtreme Machine, with voxel standardized at 300 mm, and radiation time of 11.26 seconds. The equipment operates at fixed 90 kV and 10 mA. All images are processed and analyzed in CS 3D Imaging Software 3.2.9 (Carestream Health Inc).

Patient within the age group of 18 to 50 yrs with erupted or impacted mandibular third molar was included in the study. The CBCT images of patient with the fracture in jaw or pathological condition involving the third molar area and with history of extraction of third and second molars were excluded. Axial, sagittal, and cross-sectional images were reconstructed for all hemi-mandibles, and 3D reconstructions were used as necessary. The retromolar canals are classified into 9 categories according to the course and morphology by Narayana *et al.,* von Arx *et al*., 2011; Sisman *et al*., 2015; Patil *et al.,* 2013; Ossenberg *et al.,* 1987. A schematic diagram of all types of retromolar canals is shown in figure 1. Type I: Vertical course of retromolar canal; Type II: Vertical course of retromolar canal with additional horizontal branch; Type III: Vertical course of retromolar canal and then coursing posterosuperiorly toward the retromolar fossa; Type IV: Temporal crest canal; Type V: Curved course of retromolar canal branching mandibular foramen; Type VI: Curved course of retromolar canal branching mandibular canal; Type VII: Retromolar canal running from the retromolar fossa and opening into the periodontal ligament space; Type VIII: Running anteriorly for some distance and then coursing posterosuperiorly toward the retromolar foramen; Type IX: Running anteriorly for some distance and then coursing postero-superiorly toward the retromolar fossa foramen with additional horizontal branch foramen. The following linear measurements were taken as shown in figure 1: the horizontal distance from the midpoint of the retromolar foramen to the distal cementoenamel junction (CEJ) of the second molar, the vertical distance (height) from the midpoint of the retromolar foramen to the upper border of the mandibular canal, the width at the point of origin from the mandibular canal and the width at the point of exit in the retromolar fossa are measured in sagittal sections. The diameters of the origin of the RMCs were measured in sagittal slices. The RMCs were assigned to four groups according to their diameters: 0-1 mm, 1-2 mm, 2-3 mm and ≥ 3 mm. The CBCT images were evaluated for the presence or absence of retromolar canal by two independent oral and maxillofacial radiologists. When disagreement existed between the two observers, consensus is reached by discussion.

Statistical Analysis: Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 22. Chi square test was used to compare the prevalence of RMC based on the age and gender of study subjects. Student t test was used to compare the different study parameters related to RMC between right and left sides. The level of significance was set at P<0.05.

RESULTS

The present study comprised of CBCT images of 100 subjects in which 43% were males while 57% were females, ranging from 18-50 years with a mean of 23.5±7.6. Of 100 CBCT images, retromolar canal was found in 18 subjects (18%) whereas a total of 25 RMCs (11 left, 14 right) were detected. Both male (50%) and female (50%) have equal prevalence of RMC and the age group 21-30 years (38.9%) tended to have more RMC than the other age group but these differences are not statistically significant (P=0.51 and P=0.46) as seen in Table 1. Among the study subjects, most RMCs were type III (vertical course of retromolar canal and then coursing posterosuperiorly toward the retromolar fossa) which accounts for 43.1% and followed by type VIII (running anteriorly for some distance and then coursing posterosuperiorly toward the retromolar foramen) that accounts for 20.7% (Table 2). The distribution of subjects with different types of retromolar canals based on age and gender is shown in Table 3. It was found that 13 of 25 RMCs seen in males whereas 12 of 25 RMCs presented in females. The mean height of RMC on left side was 13.27±1.54mm and right side was 13.00±2.08mm. The mean distance from the midpoint of retromolar foramen to distal aspect of second molar on left side was 18.00±1.96mm and right side was 18.19±1.92mm. The mean width at the point of origin from the mandibular canal and the mean width at the point of exit in the visible retromolar fossa on the left side were 1.97±0.2mm and 1.90±0.4mm, respectively. On the right side, the mean width at the point of origin and the mean width at the point of exit were 1.89±0.23mm and 1.94±0.1mm as shown in Table 4. According to t-test, no significant difference existed in the height of RMC (p=0.64), the horizontal distance of RMC (p=0.84), the width of RMC at the point of origin (p=0.5) and the point of exit (p=0.82) in the left and right sides. No significant association was noted between the gender and height of RMC (p=0.60) or the horizontal distance of RMC (p=0.92). There was no significant difference found between the gender and the width of point of origin (p=0.29) or the width of point of exit (p=0.82).

DISCUSSION

This study was aimed to assess the presence of RMC along with diameter and course using CBCT scans. Based on the results, the incidence of RMC was found to be 18%. The incidence of retromolar canals in osseous and CBCT studies has been found to range from 6.1%-72%.[6] Amini *et al*. (2015) reported that the incidence of RMC was 7.3% whereas Von Arx *et al*. (2011) reported the prevalence of retromolar canal to be 25.6%. (Amini et al., 2015; Von Arx et al., 2011). The incidence of retromolar canals has been found to be varying among different populations. Ossenberg reported a higher incidence in Americans than in Japanese, Indians and Africans. This difference was attributed to hereditary and environmental influences such as nutrition, stress etc (Ossenberg, 1987). Naitoh *et al.* (2009) investigated the RMC as a subtype of the bifid mandibular canal using clinical CBCT images (voxel size 0.155 mm) and observed the RMC at a frequency of 25.4% per mandible and 13.5% per side (Naitoh *et al*., 2009). In the present study, of 18 CBCT scans on which, inferior alveolar canals were visible bilaterally, only 7 cases had bilateral retromolar canals; 11 cases had unilateral retromolar canals. In a study done by Patil *et al.* 64 of the 88 subjects with unilateral examination and 65 of the 83 subjects with bilateral examination presented with retromolar canal (Patil *et al*., 2013). von Arx *et al.* reported 4 cases of bilateral RMC on 21 bilateral mandibular canals (Von Arx *et al*., 2011). There was no difference in the occurrence of retromolar canals with regard to gender and sides of the mandible in the present study. Based on our results, the occurrence of retromolar canal was noted equally in both the gender but in contrast to these result Amini *et al*. (2015) and von Arx *et al*. (2011) reported that the occurrence of retromolar canal was higher in males. Type I had the highest prevalence (24.8%) in the study done by Sisman *et al*. (2015); while in our study, type III had the highest prevalence (43.1%). Regarding the measurement of retromolar canal, the mean distance from the midpoint of retromolar foramen to the cementoenamel junction at the distal surface of second molar was 12.76mm in the study by Amini *et al.* (2015), which was 4mm lesser than the value obtained in our study (16.2mm).

Table 1. Comparison of prevalence of retro molar canal based on the age and gender of study subjects using Chi Square Test

Variable	Category	Present		Absent		P-Value
		n	%	n	%	
Age	< 20 yrs	6	33.3%	28	34.1%	0.46
	21-30 yrs	7	38.9%	29	35.4%	
	31-40 yrs	4	22.2%	10	12.2%	
	41-50 yrs	1	5.6%	15	18.3%	
Gender	Males	9	50.0%	34	41.5%	0.51
	Females	9	50.0%	48	58.5%	

Table 2. Distribution of Retro molar canals with different types on sides and gender among study subjects

Types of RMC	Left Side		Right Side		Total		Gender	
	n	%	n	%	n	%	Males	Females
Type I	1	4.5%	2	7.1%	3	18.8%	0	3
Type II	1	4.5%	0	0.0%	1	4.5%	1	0
Type III	4	18.1%	7	25.0%	11	43.1%	7	4
Type VI	2	9.1%	1	3.5%	3	12.6%	2	1
Type VIII	3	18.6%	2	7.1%	5	20.7%	3	2
Type IX	0	0.0%	2	7.1%	2	7.1%	0	2

Table 3. Comparison of different study parameters related to Retro molar Canal between the right and left sides using Student Paired t Test

Parameters	Sides	Mean	SD	P-Value
Height of RMC	Left	13.27	1.54	0.64
	Right	13.00	2.08	
HD of RMC	Left	18.00	1.96	0.84
	Right	18.19	1.92	
Width of RMC_Origin	Left	1.97	0.20	0.50
	Right	1.89	0.23	
Width of RMC_Exit	Left	1.90	0.40	0.82
	Right	1.94	0.15	

Figure 1. a) Schematic illustrations of different configurations of the retromolar canal.
b) Schematic illustration of linear measurements taken of the retromolar canal; (X):horizontal distance from retromolar canal to second molar, (Y) height of retromolar canal, (C) width of retromolar canal, the width at the point of origin (wo) from the mandibular canal and the width at the point of exit (we) in the retromolar fossa in sagittal sections

This difference may be related to the reference point of measurement. In the study by Amini *et al.* (2015), the distance from the mesial surface of retromolar foramen was measured while in our study, the distance from the midpoint of retromolar foramen was recorded. The present study showed that the left/right side and gender had no significant difference with the horizontal distance of retromolar canal. This result was in accordance with the study done by Bilecenoglu and Tuncer (Bilecenoglu and Tuncer, 2006).

They evaluated on 40 mandible cadavers and measured the height and horizontal dimensions of the retromolar foramen and assessed for a correlation between the presence of the foramen and the dimensions. They reported the mean horizontal distance to be 11.9mm. The mean height of the retromolar canal from the midpoint of the retromolar foramen to the upper border of the mandibular canal in our study was 14.04mm; however, in the study by Amini *et al*. (2015) this value was reported to be 6.66mm.

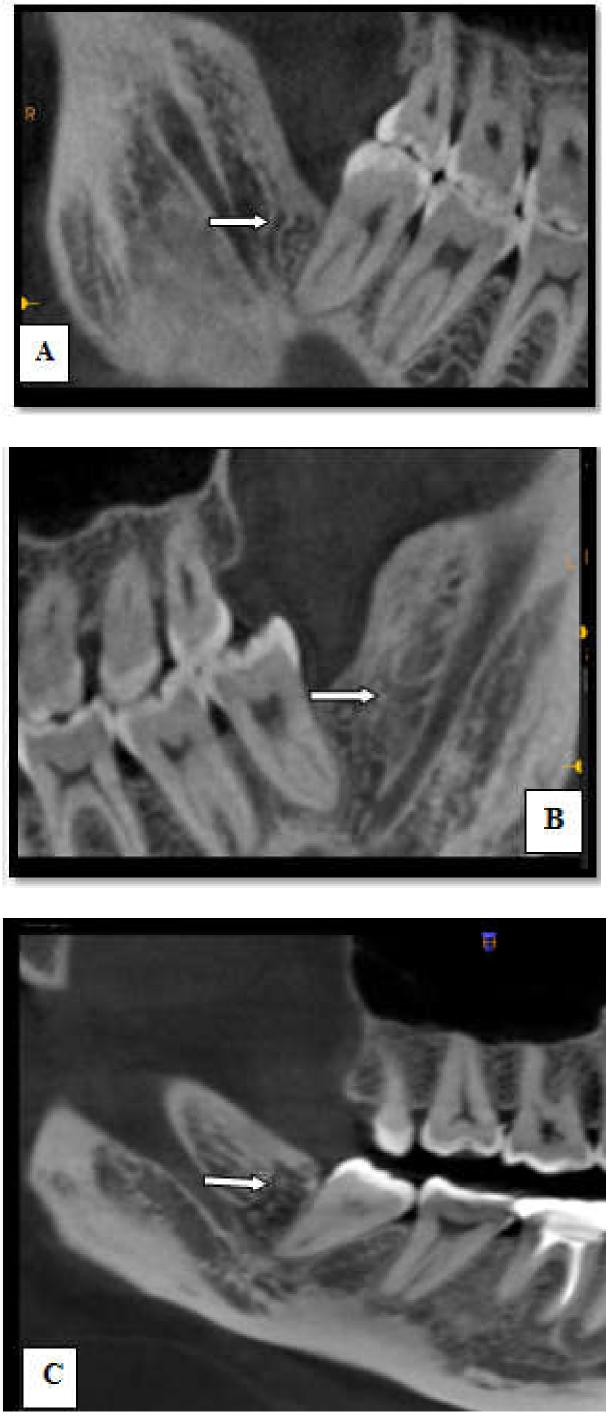

Figure 2. Different types of retromolar canal observed on CBCT scans; A-Type III, B- Type VIII, C- Type I

The difference in the results of the two studies may be attributed to the reference point of measurement of retromolar canal. Amini *et al.* (2015) reported that the female had higher mean height of retromolar canal which is in contrast to our results. Amini *et al.* (2015) also suggested that the retomolar canal length depends on the position of the retromolar foramen.

Moreover, there is no significant association with gender and the mean height of the retro molar canal.

Conclusion

The present study demonstrates the prevalence of RMC. Considering the fact that, the study has limited sample size; the prevalence was found to be 18%. The incidence f type III RMC was the most common pattern in this study. Age, gender and location had no significant association with the course and diameter of RMC. The knowledge of this anatomical variation is important for surgeons to prevent damage to the nerves arising from retromolar canal.

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