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Original Article

Cone Beam CT Evaluation of the Prevalence and Characteristics of the Retromolar Canal

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Abstract

Statement of problem: Retro-molar canal (RMC) is of clinical significance because of its neurovascular content, which may be at risk of damage during the surgical procedures of the area.

Objectives: The aim of the present study was to evaluate the frequency and anatomic characteristics of RMC by using cone beam computed tomography (CBCT).

Materials and Methods: The sample of this study consisted of 500 CBCT images (1000 sides), evaluated for the presence, type, and width of RMC. The canals were categorized into five groups based on their course as A_1 (vertical), A_2 (vertical with a horizontal branch), B_1 (curved), B_2 (curved with a horizontal branch), and C (horizontal).

Results: The study showed that 57 (11.4%) subjects and 67 (6.7%) sides had RMC in which 47 (9.4 %) were unilateral and 10 (2%) were bilateral. There was no statistically significant difference between male and female individuals in the occurrence of RMC (10.2% and 12.7%, respectively) (P-value=0.387). The most common morphologic types were B_1 (50.7%) and A_1 (23.9%), while A_2 (3%) and B_2 (4.5%) were the least frequent types. The mean width of the mandibular canal and RMC were 3.51 ± 0.55 mm and 1.30 ± 0.47 mm, respectively. These dimensions were not significantly influenced by gender (P-value=0.440, 0.569, respectively).

Conclusions: The results of the present investigation showed that the RMC was a common anatomic structure. Therefore, because of its clinical significance, it is highly recommended that dental practitioners consider this structure in pre-surgical evaluations of the region in order to avoid related complications.

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Introduction

Accessory canals are the canals branching off the main neurovascular canal and running in different courses through the bone. There are many accessory canals in the mandible, some of which are still unspecified [1]. Accessory canal injuries can be the cause for a number of post-operative complications [2, 3].

Retro-molar canal (RMC) has been found to be the second most frequent type of accessory canals in the mandible after the forward canal [4]. RMC branches off from the inferior alveolar nerve canal, behind the third molar, toward the retro- molar area [2, 5, 6].

RMC is of clinical significance because of its neurovascular contents. Several studies have demonstrated the RMC's contents to be small arteries, venules and myelinated nerve fibers [7, 8]. These elements may be at risk of damage during the surgical removal of the third molars, dental implants insertion, bone harvesting procedures, or even under the pressure of prosthetic denture in a resorbed ridge [5, 9]. Damage to the RMC might be responsible for excessive bleeding during surgical procedures, failure in the inferior alveolar nerve block, paresthesia of the gingival tissue posterior to the canine tooth, or even post-surgical hematoma or traumatic neuroma [5, 7, 9-11].

The increasing need to surgical procedures including implant insertion and removal of impacted teeth has multiplied the need for evaluating the RMC. In recent years, the use of cone beam computed tomography (CBCT) has enabled dental professionals to evaluate the desired structure through high-resolution three-dimensional images, in detail and free from superimposition [3,5,10]. A study comparing the diagnostic ability of panoramic radiography and CBCT regarding RMC showed that panoramic radiography was able to identify only 7 RMC out of 31 as diagnosed by CBCT [6]. Identification of this anatomic variation may be useful to avoid some of the post-surgical complications. Since there has not been enough information about RMC, particularly in the Iranian population, this study aimed to evaluate the frequency and anatomic characteristics of RMC by using CBCT. To the best of our knowledge, the current study used the largest sample size among CBCT studies to evaluate this structure.

Materials and Methods

The sample of this retrospective study consisted of 500 CBCT images taken for various clinical indications, during a 2-year period (from March 2014 to June 2016) in a private oral and maxillofacial radiology center in Shiraz, Iran. A NewTom VGi Cone Beam CT machine (QR SRL Company, Verona, Italy) with basic voxel size of 0.3mm obtained all the images. The examinations were performed at 4.71 mA and 110 kVp, with a scanning time of 3.6 seconds. The subjects with a history of craniofacial malformation or syndrome, trauma, orthogenetic surgery or presence of any lesion in the retromolar area were excluded from the study.

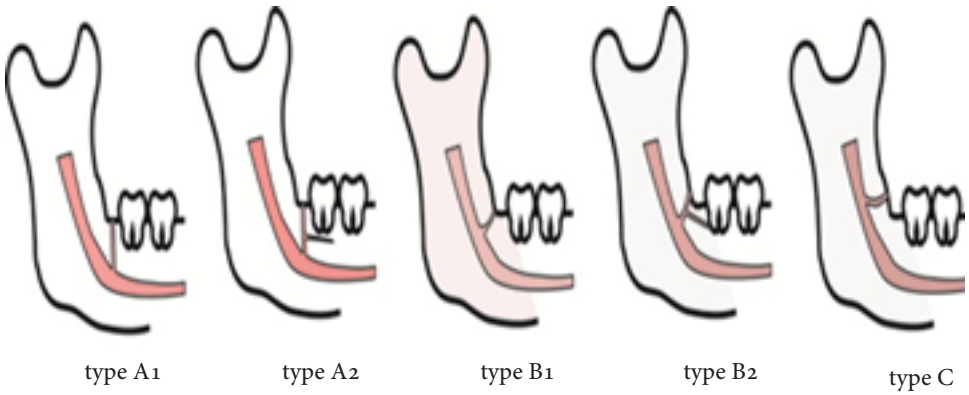

Figure 1: Schematic demonstration of retromolar canal classification

Two oral and maxillofacial radiologists evaluated the images in all three orthogonal planes (sagittal, coronal and axial) for the presence and type of RMC with consensus. The width of the mandibular canal and RMC was also measured at the point of bifurcation.

The types of the canals were categorized based on the course and morphology [6] as A_1 (vertical course), A_2 (vertical course with a horizontal branch), B_1 (curved course), B_2 (curved course with a horizontal branch), and C(horizontal course). (Figures 1 , 2)

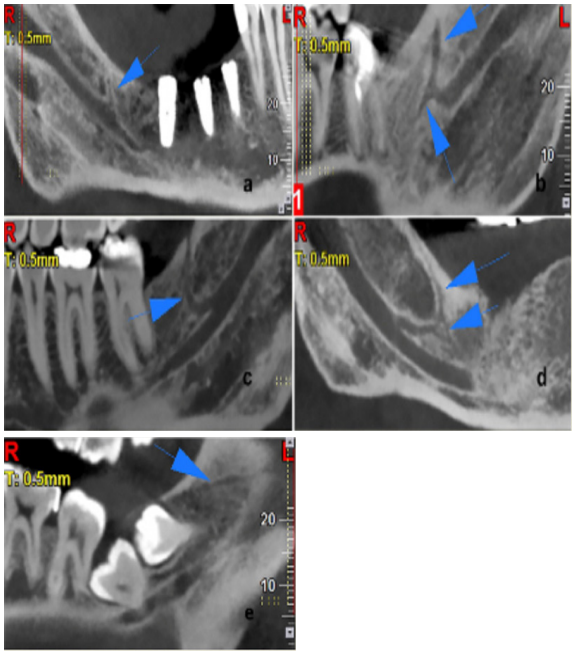

Figure 2: Sagittal CBCT plans showing different types of retromolar canal. (a) type A_1 (b) type A_2 (c) type B_1 (d) type B_2 (e) type C

Statistical analysis

Chi-square and Student's t-tests were employed to assess the relationship between the variables. SPSS version 18.0 (SPSS Inc., Chicago, IL, USA) was adopted for statistical analysis. A p-value < 0.05 was considered statistically significant.

Table 1: Frequency (percentage) of retromolar canal

	Subjects (n=500) (%)	Sides (n=1000) (%)
Presence	57 (11.4)	67(6.7)
Unilaterally	47 (9.4)	47(4.7)
In right	27 (5.4)	27(2.7)
In left	20 (4)	20(2)
Bilaterally	10 (2)	20(2)

Results

CBCT images of 500 subjects (1000 sides) were evaluated retrospectively for this study. 57 (11.4%) subjects and 67 (6.7%) sides were found to have RMC. Among these subjects, 47 (9.4%) were found to have RMC unilaterally and 10 (2%) bilaterally (Table 1). There was no statistically significant difference between the male and female subjects in the occurrence of RMC (10.2% and 12.7%, respectively) (P-value=0.387) (Table 2). The most common morphologic types were B_1 (50.7%) and A_1 (23.9%) and the least common ones were A_2 (3%) and B_2 (4.5%). (Table 3)

The mean width of the mandibular canal and RMC were 3.51 ± .55 mm and 1.30 ± .47 mm respectively, and type B (B_1 and B_2) was found to be the widest. These dimensions were not significantly influenced by gender (P-value=0.440, 0.569, respectively) (Tables 4 and 5).

Discussion

The reported prevalence rates for RMC and retromolar foramen (RMF) has been different among different studies (Table 6). This variety may be due to the ethnicity, different evaluation techniques, different scoring criteria, and sample sizes.

Studies on RMC have been conducted on dry mandibles, panoramic radiographs, CT (computerized tomography) and CBCT examinations. The study of von Arx *et al*. [6] reported a prevalence of 25.6% of RMC in CBCT and showed that among 31 RMCs detected in

Table 2: The occurrence of retromolar canal according to gender

	Male (n=255)(%)	Female (n=245)(%)	P-value*
Absence	229 (89.8)	214 (87.3)	
Presence	26 (10.2)	31 (12.7)	0.387

*Chi-square

Table 3: The distribution of retromolar canals based on type for both sides and gender

Type	n	percentage	number in side		number in Gender	
			right	left	male	Female
A_1	16	23.9	8	8	8	8
A_2	2	3	1	1	0	2
B_1	34	50.7	17	17	17	17
B_2	3	0.5	3	0	1	2
C	12	17.9	8	4	6	6
Total	67	100	37	30	32	35

Table 4: Comparison of mandibular and retromolar canals width in different genders

	Total	Male	Female	P-value*
Retromolar canal width (mm)	1.30±0.47	1.26±0.46	1.34±0.49	0.569
Mandibular canal width (mm)	3.51±0.55	3.75±0.52	3.45±0.75	0.440
Ratio	0.38±0.10	0.36±0.10	0.39±0.10	0.199

*student's t test

Table 5: Comparison of the width of mandibular and retromolar canals in different genders (n=67)

Type	Mean width (mm)	number in Gender	
		Male	Female
A_1	0.9±0.43	0.96±0.52	0.84±0.37
A_2	1.05±0.07	-----	1.05±0.07
B_1	1.51±0.42	1.44±0.42	1.58±0.43
B_2	1.5±0.17	1.7	1.4
C	1.24±0.38	1.07±0.24	1.42±0.44

CBCT, panoramic radiographs were able to identify just 7 cases (5.7% of samples). Similarly, Muinelo-Lorenzo *et al*. [3] observed the RMF prevalence to be 12.4% in CBCT images (8.8% of sides), but at the same time panoramic radiographs could identify the RMFs in only 5.3% of the samples (2.8% of sides). In other words, only 32.5% of RMFs found on CBCT images were visible on panoramic examinations. Additionally, Sisman *et al*. [18] examined CBCT images of 947 sides and detected 253 RMC (26.7%), but only 29 RMC were traceable on panoramic radiographs (3.1%). These studies concluded that panoramic radiography was not sufficient for evaluation of RMC and the foramen due to the superimposition of various structures over the area including the airways, soft palate, ghost image of the contralateral side, while CBCT study provided the opportunity of evaluating the desired structures in all orthogonal planes free from superimpositions and with a higher resolution. Studies on dry mandibles obtained varying rates of prevalence ranging from 16% to 72% , probably due to dissimilar methodologies [13-17]. Besides, most of these studies have evaluated RMF instead of RMC. In a study on 2500 dry mandibles, Ossenberg [13] found different prevalence rates of RMC among different populations. His study reported higher prevalence in native American population compared to Africa, Europe, India, and north East Asia [13]. Priya *et al*. [15] showed this

prevalence to be 17.8% (5.1% bilateral, 12.7% unilateral) in South India. In another study on the same ethnic population, Tiwari *et al*. [16] reported almost similar results as 16% (3% bilateral, 13% unilateral). These two studies could confirm the idea of the influence of ethnicity on the incidence of RMC. Furthermore, CBCT studies showed the prevalence of 8.5% in Korean [10], 28.1% in Turkish [4] and 52% (37% of sides) in the Japanese population [5].

Different scoring criteria can also contribute to different reported prevalence rates. For example, studies conducted on dry mandibles may consider 0.5 mm [13] or 1mm [12] as the minimum size of the RMF. Additionally, studies have used different classifications of RMC. Patil *et al*. [2], which reported a prevalence of 65.3%, included the canals which connected the third molar to the retromolar fossa as well. On the other hand, Han and Hwang [10] included a type of RMC in their studies that was not branched off the inferior alveolar nerve but originated from a separate foramen in the ramus. In the present study, RMC was defined as the canals branching off the inferior alveolar nerve and coursing into the retromolar fossa. Our result showed that 11.4% of the samples (9.4% unilaterally and 2% bilaterally) and 6.7% of sides (67/1000) had RMC.

Most of the RMCs in the present study were found to be in type B_1 with a frequency of 50.7% of all RMC, followed by A_1 (23.9%) and C (17.9%). A similar classification was used with von Arx *et al*. [6] They reported the frequency of the types in the following order: A_1 (41.9%), B_1 (29%) and A_2 (16.1%). Both studies showed that A_1 and B_1 are the most common types and the difference in the

Table 6: Summary and comparison of the present study with other studies on retromolar canal

	Study	Sample size Subjects/sides	Prevalence Total/side	Population
CBCT studies	The present study(2016)	500/1000	11.4% / 6.7%	Iran
	Thomas von Arx(2011)	100/121	----/ 25.6%	
	Giuseppe Lizio(2012)	187/233	16% / 14.6%	
	Seema Patil(2013)	171/----	75.4% / ----	
	Muinelo-Lorenzo(2014)	225 / 450	36.8% / 22.8%	Korea
	Sang-Sun Han(2014)	446 / 892	8.5% / 5.0%	Japan
	Kaan Orhan(2011)	242 / 484	66.5% / 46.5%	
Cadaver studies	Ossenberg NS.(1987)	2500/----	72% /----	Africa, Europe, India northeast Asia
	Narayana K.(2002)	242/----	21.9% /----	South India
	Priya R.(2005)	157/----	17.8% /----	South India
	Tiwari S(2015)	100/----	16% /----	India
	Rossi, Ana Claudia(2012)	100/----	16% /----	Brazil
Panoramic versus CBCT studies	Thomas von Arx(2011)	100 / 121	----/ 5.8%	
	Muinelo-Lorenzo(2014)	225 / 450	16.8% / 9.3%	
	Sisman(2015)	632 / 947	---- / 3.1%	

reported values could be explained by the influence of ethnicity. Such information is hardly comparable in studies due to the differences in classification criteria.

In the present study, the mean width of RMC was found to be 1.30 ± .47mm with type B (B_1 and B_2) as the widest type (1.51 ± .42). Although the findings showed that this width is slightly greater in females, the difference is not statistically significant. Similar findings were reported by previous studies. Han and Hwang [10] and von Arx [6] reported a mean width of 1.13mm and .99mm, respectively. However, Narayana *et al*. [14] reported a relatively greater width (1.5-4.35mm). This inconsistency can be justifies as their study was conducted on cadavers; moreover, the study did not specify the exact level of measurements.

The findings of the present investigation showed that there was not any gender predication for the occurrence of RMC. Similar findings were reported by most of the previous studies [2, 6, 7, 13-15], while Pyle *et al*. [19] witnessed a higher prevalence of RMF in male dry mandibles (9.6%) compared to those the females (6.1%).

As mentioned earlier, RMC has clinical importance because of its content. Damage to the RMC during different surgical procedures can lead to significant post-operative complications [5, 10, 20, 21].

Conclusions

The present study showed that the RMC was a common anatomic structure. Thus, because of its clinical significance, it is highly recommended that dental practitioners consider this structure in pre-surgical evaluations of the region in order to avoid the allied complications.

Acknowledgements

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Conflict of Interest: None declared.

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