Original Article

Examining the Prevalence and Location of the Retromolar Canal Using Cone-Beam Computed Tomography Imaging

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Abstract

Background and Purpose: The retromolar canal (RMC) is an anatomical structure in the mandible possibly containing feeding vessels and nerves, which conveys accessory innervation to the mandibular molars or contains aberrant buccal nerves. Damage to this canal can lead to paresthesia and traumatic neuroma. Therefore, it is very important to be aware of the presence of this canal in posterior mandible surgeries. This study aimed to determine the prevalence and location of the RMC in cone-beam computed tomography (CBCT) imaging. **Materials and Methods:** This study was performed on CBCT stereotypes of 117 patients (74 females and 43 males) in the archives of the Department of Oral and Maxillofacial Radiology (OMFR), School of Dentistry, Ahvaz Jundishapur University of Medical Sciences, who had referred for CBCT scan for various reasons. Radiographs were screened to find the retromolar canal. It was followed by linear measurements (i.e., the horizontal distance from the midpoint of the retromolar foramina (RMF) to the distal of the seventh molar, the diameter of the RMC, and the height of the RMC). Data were analyzed by SPSS software Version 22.0, and the results were tabulated using the t-test and Pearson correlation test. **Results:** The prevalence of the RMC was 14.5%, equivalent to 17 cases. Linear measurements included the mean horizontal distance from the RMC to the distal of the second molar (15.7±2.5 mm), the mean width of the RMC (2±0.3 mm), and the mean height of the RMC (7.1±1.1 mm). There was no statistically significant association between the prevalence of the RMC and side, gender, and age. **Conclusions:** Given the importance of this canal, it is recommended to use CBCT before the extraction of wisdom teeth close to the canal.

Keywords: Cone-Beam Computed Tomography, Retromolar Canal

Introduction

The retromolar canal (RMC) is an anatomical structure in the mandible, a bifurcated inferior alveolar canal. It normally arises from the mandibular canal behind the third molar and travels anterosuperiorly to the retromolar foramina (RMF) in the retromolar fossa area [1]. The RMC contains neurovascular bundles (NVBs), including arteries, numerous veins, and myelinated nerve fibers. This canal may contain accessory feeding vessels to the mandibular molars or aberrant buccal nerves. Thus, it is very important in mandibular surgeries, including extraction of the impacted third molar, implant, and sagittal split osteotomy, located in the retromolar area [1, 2]. However, the structure of the RMC is still unclear. This canal may involve accessory innervation of the mandibular molars or contain aberrant buccal nerves [3, 4]. The neurovascular content of the RMC is very important in retromolar surgery [2]. Damage to the RMC during mandibular surgery can cause bleeding, paresthesia, and traumatic neuroma. This canal can also act as a conduit for the spread of infection or tumors [3].

Very few studies have been performed on the RMC, most of which have involved the analysis of the RMF and emphasized the importance of diagnosis and the prevalence of RMC in CBCT images [5-11]. High-quality CBCT has recently succeeded in confirming various mandibular canals not detected by panoramic radiography [3].

CBCT is a new oral and maxillofacial imaging technology fixed to a divergent or cone-shaped source of ionizing

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radiation and a two-dimensional (2D) surface detector fixed to a rotating gantry to obtain multiple consecutive images in a complete scan of the target area. This technology was first used in 1982 for angiography and then maxillofacial imaging. This method uses a divergent or cone-shaped ionizing X-ray source and a 2D detector fixed to a rotating gantry to obtain multiple consecutive images in one complete scan around the target area [12].

CBCT and observation information is reconstructed simply by using a personal computer. Some manufacturers have also developed a range of software with advanced functions for specific applications, such as implant placement or orthodontic analysis. Finally, the availability of cursor-driven measurement algorithms allows the development of interactive capabilities for real-time dimensional evaluation, interpretation, and measurement. Despite the high attractiveness of CBCT, this technology has several limitations in terms of cone-beam imaging geometry, detector sensitivity, and contrast resolution. The images produced a lack of the resolution and benefits of conventional CT images. However, CBCT technology has a major impact on the maxillofacial imaging used in all aspects of dentistry. Today, it is also widely used for therapeutic applications. CBCT should not be considered a substitute for conventional panoramic radiography but should be a complementary method for specific applications [12].

Due to the low prevalence and importance of knowing the existence of this canal in surgical procedures, we decided to investigate the prevalence and location of it in CBCT images in Ahvaz. This was conducted to prevent damage to the RMC during surgeries of the posterior mandibular region, such as split sagittal osteotomy, implantation, etc., by increasing dentists' awareness in this area.

Therefore, this study seeks to answer the following question:

What are the prevalence of the RMC and its location in CBCT images?

Materials and Methods

This study was conducted retrospectively. The research population consisted of CBCT images in the archives of the Department of Oral and Maxillofacial Radiology, School of Dental Medicine, Ahvaz Jundishapur University of Medical Sciences, related to the posterior mandible. These people had referred to the Department of Oral and Maxillofacial Radiology, School of Dental Medicine in 2015-2017 for different reasons. The sample size was calculated to be 117.

Method:

All stereotypes were prepared with a NewTom VGi machine (Verona, Italy) with 110 kvp, 2.04ma,3.6s exposure conditions, and had 8*12 fov, 0.3 mm voxel size and evaluated by NNT Viewer software under the supervision of a maxillofacial radiologis (Figure1-A). CBCT images included reconstructed axial, cross-sectional, and panoramic sections (Figure 2). The presence or absence of the RMC was recorded, and the prevalence of different types was assessed according to the Von Arx study (7), including (Figure1-B):

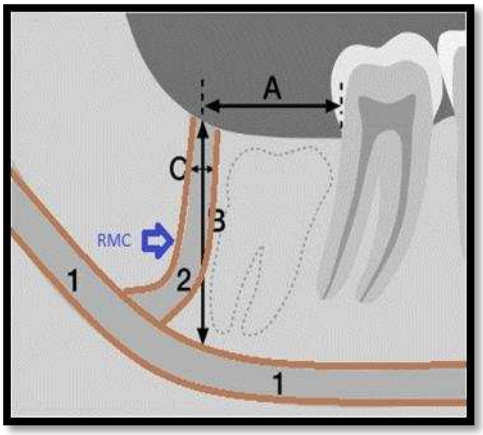
A1: Vertical branch of the RMC
A2: Vertical branch of the RMC with an additional horizontal branch
B1: Curved branch of the RMC with an additional horizontal branch
C: Horizontal branch of the RMC

If there was an RMC, the following distances were measured:

1) The horizontal distance from the midpoint of the RMF to the distal CEJ of the second molar
2) The vertical distance from the RMF to the superior border of the inferior alveolar canal
3) The width of the RMC 3 mm lower than that of the RMF

All information was collected in one information form. Finally, the data were analyzed under the supervision of a statistical consultant.

A



B

Figure 1: A) CBCT Device, B) Measurement Procedure

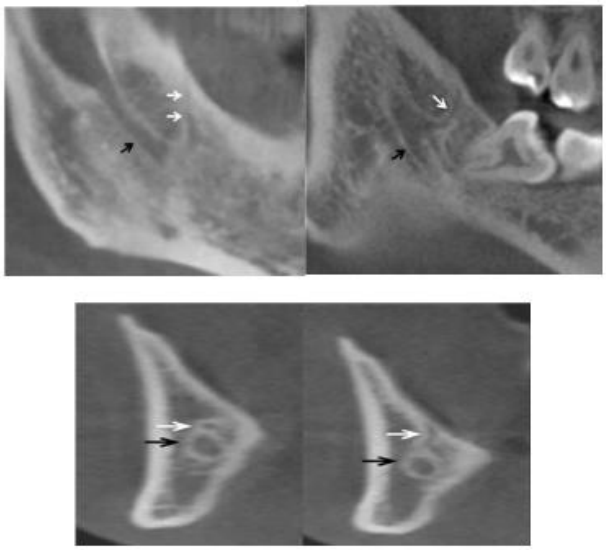


Figure 2: Studied Samples

Data Analysis

Descriptive statistics of the study, including mean, standard deviation, percentage, drawing Tables, and Graphs, were analyzed by SPSS software Version 22.0. and using the t-test and Pearson correlation test.

Results

From among the 117 CBCT stereotypes examined, 17 RMCs with a prevalence of 14.5% were found in 16 patients, 10 in women (8.54%), and 6 in men (5.12%).

The clients' mean age was 39.74 (minimum age: 15 years old and maximum age: 75 years old).

Out of these 17 samples found, 9 had a canal at the right side (7.69%) and 8 at the left (6.84%).

Moreover, one case had a bilateral RMC (0.85%).

In samples with canals, the following distances were measured:

1) The horizontal distance from the midpoint of the RMF to the distal CEJ of the second molar
2) The vertical distance from the RMC to the superior border of the inferior alveolar canal
3) The width of the RMC 3 mm lower than that of the RMF

Table 1: Descriptive Statistics of Linear Measurements Made of the RMC (in mm)

	No.	Min Length	Max Length	Mean ± SD
Distance from the Midpoint of the RMC to the Distal CEJ of the Seventh Molar	17	12.3	20.1	15.7±2.5
RMC Width	17	1.6	2.4	2±0.3
RMC Height	17	5.3	8.8	7.1±1.1

According to Table 1, the mean distance from the midpoint of the RMC to the distal CEJ of the seventh molar is 15.7±2.5 mm, the width of the RMC is 2±0.3 mm, and the height of the RMC is 7.1±1.1 mm.

Table 2: Relationship between Linear Measurements Made of the RMC (in mm) for each Gender Separately

	Female	Male	P-Value
	Mean ± SD	Mean ± SD	
Distance from the Midpoint of the RMC to the Distal CEJ of the Seventh Molar	15.2±2.5	16.4±2.6	0.38
RMC Width	2.0±0.3	2.1±0.2	0.90
RMC Height	7.1±1.0	7.3±1.2	0.69

According to Table 2, the mentioned measurements were compared for both genders. An independent t-test was used for this purpose. The results showed that there was no statistically significant difference between the mean factors of the distance between the midpoint of the RMC to the distal CEJ of the seventh molar (P = 0.38), the width of the RMC (P = 0.90), and the height of the RMC (P = 0.69) in both men and women.

Table 3: Relationship between Linear Measurements Made of the RMC (in mm) and Patients' Age

	Pearson Correlation	P-Value
Distance from the Midpoint of the RMC to the Distal CEJ of the Seventh Molar	0.22	0.41
RMC Width	-0.16	0.54
RMC Height	0.29	0.25

The mentioned measurements were compared for different ages. To do this, the Pearson correlation test was used. The results indicated that there was no linear relationship between the variables of the distance between the midpoint of the RMC to the distal CEJ of the seventh molar (P = 0.41), the width of the RMC (P = 0.54), and the height of the RMC (P = 0.25) with the age variable (Table 3).

Discussion

This study aimed to investigate the prevalence and location of the RMC using CBCT imaging. The prevalence of the RMC was examined in 117 patients using CBCT, from which 17 (14.5%) had this canal. The prevalence of this canal has

been reported in various ossicular, CBCT, and panoramic studies.

Limited studies on cadavers have reported a prevalence of more than 72%, including the smallest foramina size for output on the bone (13). In a study using CBCT, Naitoh et al. considered the RMC as a bundle of bifid mandibular canals (BMCs). They stated that the prevalence of this canal is equal to 25.4% [13]. The prevalence of this canal in South America, India, and Europe was reported to be 12.9-26.58%, 12.2-21.9%, and 8.1-25.6%, respectively [14]. The prevalence of this canal was reported to be 25.6%, 10.2%, 21.9%, 4.3%, and 35%, by Von Arx et al. [12], Kang et al. in Korea [15], Narayana et al. in India [16], Singh et al. [17] and Sanchis et al. [18], respectively. This difference in results can be attributed to ethnicity and geographical differences [1].

In a study of 100 patients, Von Arx et al. identified only seven of the 31 RMCs observed in CBCT panoramic images [12]. Panoramic radiography has limited ability to detect this canal. According to Von Arx et al., one possible reason is the very low thickness of this canal at 3 mm beneath the RMF, whose mean diameter was reported to be 0.99 mm [12]. The lower reported prevalence of this canal in panoramic than in CBCT can be due to problems with panoramic radiography, including reduced detail viewing, irregular magnification, geometric distortion, and overlapping anatomical structures, which interferes with panoramic detection. There are also some false positives in panoramic images due to overlapping anatomical structures. Due to the junction of the mylohyoid muscle and the thin cortical boundaries of the mylohyoid NVBs on the medial surface of the ramus, local osteocondensation of the bone may be misdiagnosed as canal variation.

Another panoramic problem is the Ghost images of the opposite mandible, airways, soft palate, and uvula, leading to false-negative detection. Nevertheless, since panoramic radiography is an initial radiograph for the general assessment of the patient, CT is prescribed in cases when there is probably a sub-canal in panoramic images [19]. Hence, another factor contributing to the difference in the prevalence of this canal is the different techniques used in research and the difference in the type of devices and different exposure conditions. Pyle et al. examined dry skulls of the American and Caucasian populations. They reported that there was no statistically significant difference between the different races [20].

In our study, from the 17 samples found, 9 had an RMC on the right side (7.69%), 8 on the left (6.84%), and one bilateral (0.85%). There was no statistically significant difference between the two sides. Similarly, Nilton et al., Patil, Tuncer, Bilecenoglu, et al., Sawyer and Suazo, Kiely et al., Von Arx et al. concluded that there was no statistically significant difference between the presence of the RMC in the two sides. However, Han, Hwang, and Narayana et al. reported greater canal prevalence on the right side. Motta-Junior et al. and Priya et al., on the other hand, reported a greater canal prevalence on the left side [14]. Most studies have reported that the RMC is often unilateral, while Sagne et al. (demonstrated a high prevalence of a bilateral canal in their studies [12]. Amini et al. examined 49 cases in their research from which only two had a bilateral canal, and the other six had a unilateral canal [1]. Priya et al. examined 157 dry skulls and reported a bilateral canal prevalence of 5.1% [21].

Moreover, this study concluded that the prevalence of this canal is higher in women than men, but this difference was not statistically significant. As in our study, the results of the studies of Amini et al. [1] and Von Arx et al. [12] indicated that this canal was more prevalent in women than men. In the study of Patil et al. [22], there was no statistically significant difference between the two genders on both sides. In the study of Ahmet et al., the presence of this canal was reported in female patients and mainly on the right side [11]. In this study, three different measurements were performed to determine the location of the RMC:

- Distance from the midpoint of the RMF to the distal of the seventh molar
- RMC diameter
- RMC height

The mean distance from the midpoint of the RMF to the distal of the seventh molar was 15.7±2.5 mm, the diameter of the canal was 2±0.3 mm, and the height of the canal was 7.1±1.1 mm. There was no statistically significant difference in these sizes between men and women. Moreover, there was no linear relationship between the measures and the age.

Kaufman et al. reported the presence of bilateral sub-canals 1-2 mm in diameter at the anterior mandibular ramus [23]. In the study by Von Arx et al. [12], the mean distance from the RMF to the distal CEJ of the second molar was 15.16 mm, which is 3 mm more than the measurements obtained in the study by Amini et al. This difference can be attributed to the desired reference points. Similar to our study, Von Arx also measured the distance from the midpoint of the RMF. However, Amini et al. measured the distances from the mesial of this foramina. Moreover, in the study of Von Arx et al., the presence of the third molar was not one of the sample inclusion criteria, while the third-molar extraction could lead to the displacement of the second molar and, consequently, a change in horizontal dimensions.

Bilecenoglu and Tuncer studied dry skulls and reported an average size of 11.9 mm [24]. The mean height of the RMC from the midpoint of the RMF to the superior border of the inferior alveolar canal was 6.66 mm in the study of Amini et al. and 11.34 mm in the study of Von Arx [1,12]. These differences in measurements in various studies can be attributed to the different reference points and accuracy and various techniques utilized in various studies.

Conclusions

This study reported that the prevalence of the retromolar canal (RMC) in CBCT images was 14.5%. The results showed no statistically significant difference in the presence of the RMC in men and women on the right and left sides. It is important to determine the presence of this canal using CBCT to extract the third molars very close to the mandibular canal in the panoramic. The clinician will be aware of inadequate preoperative anesthesia and unexpected bleeding during surgery by identifying this anatomical variation and evaluating it before posterior mandible surgeries, third-molar extraction, bone grafting extraction, and sagittal split osteotomy.

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