Evaluation of Retromolar Canals using Cone Beam Computer Tomography

Avaliação do canal retromolar por meio de tomografia computadorizada de feixe côncico

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ABSTRACT
The aim of this study was to evaluate the prevalence, location and clinical implications related to the presence of the retromolar canal (RMC) on cone beam computed tomography(CBCT). CBCT images of patients from Latin America Institute for Dental Research and Education - Curitiba,Pr,Brazil, was performed from June/2008 to February/2013. The interpretation was performed by a calibrated examiner, according to the criterias: presence, location and classification of the RMC variation, as well as, measurements of horizontal distances of the RMC in relation to the buccal bone cortical and diameter of these canals. A total of 751 CBCT images were interpreted: 486(64.7%) from females and 265 (35.3%) from male patients, with mean age of 54.57 (±13.23) years. The presence of RMC was observed in 58 (7.7%) patients, 23 men and 35 women. A total of 1502 hemi-mandibles were analyzed. The RMC was identified in 69(4.6%) hemi-mandibles, 44(63.8%) from females and 25(36.2%) from males. Thirty (42.8%) RMC were observed on the right side and 40 (57.2%) on the left one. The type B1 (n=33; 47.1%) was the most common, followed by the type A1 (n=18;25.7%). The mean
diameter of RMC was 0.97mm (±0.44), and the mean distance between retromolar foramen and the buccal cortical of the mandible was 4.12mm (±1.35). There were no significant differences between the distances and genders, and distances and sides (p > 0.05). The prevalence of RMC was 7.7% in the studied sample; they were predominantly unilateral and showed to be type B1.

**Keywords:** Retromolar canal, Anatomical variation, Cone beam computer tomography.

**INTRODUCTION**

RMC is an anatomical variant of the mandibular canal and its trajectory is not constant, changing an area to be supplied. The identification of RMC becomes important for surgical procedures, such as, extraction of third molars, implant placement and bone graft procedures.

Injuries to this canal during surgical procedures are related to traumatic neuromas, profuse bleeding, significant postoperative swelling and temporary or permanent sensory disturbances. Some studies suggest relationship between the damage to this canal and its impact on temporal and buccinator muscle fibres. On the other hand, some authors suggested the hypothesis that presence of RMC makes oropharynx infection spreads easier in the blood circulation because of its neurovascular bundle.
of this canal by conventional radiographic techniques is limited due to overlapping anatomical structures. For this reason, CBCT provides a significant contribution to diagnostic and treatment planning. Demonstrated prevalence of RMCs ranging from 14 to 65%.

In the literature, there are few investigations aiming to describe the morphology and importance of RMC position, important factors for surgical procedures in this region. Due to this fact, the aim of this study was to evaluate the prevalence, classification and location of the RMC on CBCT images.

2 MATERIALS AND METHODS

This transversal and retrospective observational study was approved by Local Ethics and Research Committee at (887.888/2014).

Using a statistic proportion sample calculation for a confidence interval of 95% and the maximum error of 2%, assuming p = (1-p) = 0.5, the size of the sample was based on the number of CBCT images (approximately 3,000 images). The sample size was estimated in 1,334 images.

The overall sample consisted of 1544 hemi-mandibles (772 patients) for whom pre-operative CBCT imaging was performed from June/2008 to February/2013 for various clinical indications, mainly for planning implants, impacted-tooth extractions and orthodontics treatments in the Radiology Department of Latin America Institute for Dental Research and Education – (ILAPEO, Curitiba, PR, Brazil). 3D images were obtained using a CBCT unit Galileos (Sirona, Bensheim, Germany). All images were performed using the following protocol for patient position and exposure acquisition parameters: occlusal plane parallel to the floor, 14 s, FOV 15x15 cm², 42 mAs, high contrast, 85 kV and 0.3 mm slice thickness. The exclusion criteria were the following: images with the presence of pathological processes in the posterior region of the mandible and the presence of any artifacts that could affect the image quality. All CBCT scans analysis were performed using the Galaxis software version 1.7 (Sirona, Bensheim, Germany).

Radiographic Assessment and Measurements

All CBCT images interpretation were performed on a liquid crystal display monitor with a resolution of 1366 x 768 LCD Dell (Dell, Texas, USA) in a low-light room, by one trained examiner and in case of doubt another specialist was consulted. In order to assess intra-examiner variability, the CBCT images of 30 patients were randomly selected, and
the same examiner performed a re-measurement after one month. The following measurements were performed:

1) Variations of RMC were classified into five categories according to their course and morphology \(^1,^2\) (Fig.1): type A1: vertical course of RMC; type A2: vertical course of RMC with additional horizontal branch; type B1: curved course of RMC; type B2: curved course of RMC with additional horizontal branch; type C: horizontal course of RMC.

Figure 1. Schematic drawing representing the anatomical variations of the retromolar canal according Von Arx et al. 2011.

2) Location of RMC (Fig.2): Sagittal reconstructions were rotated horizontally according to the course of RMC. Reference lines have been moved buccal/lingual to posterior/anterior looking for the best image of the course of the RMC for individual observation in axial and parasagittal images, the following measurements were performed: a) measurement of the most anterior point of the curvature of the RMC compared to buccal cortical bone (horizontally); b) measurement of the buccal cortical bone to the retromolar foramen, 3mm below the crest.

3) The diameter of the retromolar foramen was measured 3 mm below the crest in axial images\(^2,^2^1\).

Figure 2.A. Sagittal cross sections showing images of the RMC. B. Parasagittal cross sections for measurement the distance between buccal cortical bone to the retromolar foramen (3.10mm). C. Axial cross sections showing the diameter of retromolar foramen (1.06mm).
Statistical analysis

Statistical analysis was performed using SPSS® version 21.0 for Windows (IBM Corporation, Armonk, NY). Descriptive statistics were performed. The level of intra-examiner agreement was assessed by Dahlberg’s error (< 3%). The x² test and the t-test were used to test differences in frequency and the morphologic characteristics of RMC between genders. Differences were considered significant at p<0.05.

3 RESULTS

Were analyzed 1544 CBCT images of 772 individuals. According to the exclusion criteria, 42 CBCT images were excluded: 31 with inadequate image quality; eight patients images presented metallic artifacts in the region (presence of implants or mini-implants and three patients images with radiopaque lesions compatible with bone sclerosis. The sample consisted of 751 CBCT, 486 (64.7%) females and 265 (35.3%) males, with mean age of 54.57 (±13.23), ranging from 14 to 93 years. The presence of RMC was observed in 58 (7.7%) patients, 23 men and 35 women. A total of 1502 hemi-mandibles were analyzed. The RMC was detected in 69 (4.6%) hemi-mandibles, 44 (63.8%) females and 25 (36.2%) males. One hemi-mandible, was observed presence of two RMC, a total of 70 RMC observed. Were observed 30 (42.8%) RMC on the right side and 40 (57.2%) on the left side. The type B1 (n =33; 47.1%) was the most common, followed by type A1 (n=18, 25.7%). A total of 3 (10.3%) women and 2 (6.9%) men showed double RMC.

The distribution of frequency of anatomical variations and gender is described in Table 1. The prevalence of type B2 was significantly higher in men compared with women. Women showed a higher frequency of type C compared to men(p<0.05). In the total sample, one patient showed two RMC on the same side, being classified as both type A1 and B1, since it did not meet the criteria for classification into any other group. The mean diameter of RMC was 0.97mm (±0.44) ranging 0.86 to 1.07mm, the mean distance between retromolar foramen and the buccal cortical of the mandible was 4.12mm (±1.35) ranging 3.79 to 4.44mm and the mean distance between cortical curvature of RMC and buccal cortical of the mandible was 3.72mm (±1.27) ranging 3.41 to 4.02mm. There were no significant differences between distances and gender, and distances and sides (p > 0.05)
Table 1. Correlation of frequency between anatomical variations and gender.

<table>
<thead>
<tr>
<th>RETROMOLAR CANAL</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n(%)</td>
<td>n(%)</td>
<td>n(%)</td>
</tr>
<tr>
<td>Type A1</td>
<td>6(8.6)</td>
<td>12(17.1)</td>
<td>18(25.7)</td>
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<tr>
<td>Type A2</td>
<td>2(2.9)</td>
<td>2(2.9)</td>
<td>4(5.8)</td>
</tr>
<tr>
<td>Type B1</td>
<td>11(15.7)</td>
<td>22(31.4)</td>
<td>33(47.1)</td>
</tr>
<tr>
<td>Type B2</td>
<td>5(7.1)</td>
<td>0(0.0)</td>
<td>5(7.1)</td>
</tr>
<tr>
<td>Type C</td>
<td>0(0.0)</td>
<td>8(11.4)</td>
<td>8(11.4)</td>
</tr>
<tr>
<td>Type A1 e B1</td>
<td>2(2.9)</td>
<td>0(0.0)</td>
<td>2(2.9)</td>
</tr>
<tr>
<td>Total</td>
<td>26(37.2)</td>
<td>44(62.8)</td>
<td>70(100)</td>
</tr>
</tbody>
</table>

4 DISCUSSION

Because some complications may occur during or after surgical procedures in the posterior region of the mandible and their occurrence is associated with the presence of RMC\textsuperscript{16,21}, we proposed to describe the prevalence, location and clinical implications related to the presence of RMC on CBCT images. In the present study we evaluated 751 subjects, the type B1 was the most frequent and an unusual presentation of double unilateral RMC. The literature showing a prevalence range from 1% to 72% in dry mandibles\textsuperscript{1,4,19,23} and 12.4 to 46.8% in \textit{in vivo} studies\textsuperscript{2,13,20}. The prevalence of RMC observed in this study (7.7%) is lower compared to other studies that used the same methodology: 14.6%(34/233)\textsuperscript{20}; 8.8%(40/450)\textsuperscript{13} and 12.16%(216/1340)\textsuperscript{20}. Our results showed predominantly unilateral presence of RMCs, in accordance with the majority of studies that mentioned that there was no difference in the occurrence of RMCs with regarding the sides of the mandible\textsuperscript{2,12,13,21,22}.

According to the classification, type B1 (n=33, 47.1%) was the most frequent in the present study, followed by type A1 (n=18, 25.7 %). This is in accordance with Patil et al. 2013\textsuperscript{12} who observed prevalence of 75.2% (97/129) of type B1 RMC, followed by type A1 (n=19/14.7%). On the other hand, others studies that used the same classification showed a higher frequency for type A1: 41.9%(n=13)\textsuperscript{2}; 39.8 %(n=86)\textsuperscript{21} in contrast to type B1: 29% (n=9) \textsuperscript{2}; 24% (n=52)\textsuperscript{21}. In this study we added a previously undescribed canal presentation: presence of two RMCs on the same side, which did not meet the criteria for classification into any other group. There are different classifications of the course of the RMC\textsuperscript{1,2,10,12} We used the classification described by Von Arx et al.2011\textsuperscript{2} based on the classification of Ossenberg 1987\textsuperscript{1}, which distinguishes the course of the RMC in five different types.
In the present study, the diameter of RMCs was determined 3mm below the retromolar foramen, because it is not always possible to observe its externalizing. Due to this fact, a variation between 0.20 to 2.66mm in the diameter of RMC was observed, corroborating with previous studies in which measurements had been carried out following the same methodology. Others studies that used unspecific measuring point showed variations from 0.8 to 3.6 mm. In the present study, the mean distance between retromolar foramen and buccal cortical of the mandible was 4.12mm. Considering the use of mandibular ramus as a donor site for onlay grafting prior to implant placement, the bone graft should have dimensions of approximately 3-5 mm in thickness, 30-35 mm in length and do not exceed 10mm in height. Due to this fact, the knowledge of the RMC position in relation to buccal cortical bone of the mandible should be emphasized. Two-dimensional images, such as panoramic radiographs, may limit the observation in posterior region of the mandible. Pre-operative images using only panoramic radiograph may lead to underestimation of the presence of RMC and to surgical complications, which could have been avoided. Because of these limitations, many studies have used CBCT to observe the exact location and relationship to adjacent anatomical structures.

Surgical procedures involving the posterior region of the mandible need to consider the clinical implications of RMC. Despite retrospective characters of this study, it can be highlighted as main limitation, the difficulty to access clinical information regarding possible injuries to the RMCs in the posterior region. However, it should be emphasized, the retromolar region represents a frequently access site during third extraction and a donor site of harvesting bone blocks, absence in identification of RMC and foramen might put patient at risk for surgical damage during surgery procedures in the mandible, that are related to profuse bleeding, significant postoperative swelling and sensory disturbances on the retromolar region. Thus, we should be warned that diameter and exact position of the RMC in relation to the buccal cortical bone of the mandible represents relevant factors for visualization. In conclusion, the prevalence of RMC was 7.7% in the studied sample, predominantly unilateral, and classified as type B1.

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REFERENCES


