Retromolar canal: a classic analysis with CBCT in South Indian population

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SUMMARY
The Retromolar canal (RMC) is an anatomic variation, the identification of which has become a clinical obstacle as the demand for surgical procedures in the retromolar area of the mandible has increased. The inferior alveolar nerve innervates the third molar and some of the muscles around the posterior region of the mandible, making surgical treatments in the retromolar area more challenging. The aim of this study was to evaluate the incidence of RMC using Cone Beam Computed Tomography (CBCT) and to evaluate the prevalence, course, and pattern of occurrence of RMC. CBCT images of 160 patients were collected and screened in the three spatial planes on both right and left sides for the presence of RMC. The incidence rates were determined according to gender, location, and type of RMC. Obtained data were subjected to statistical analysis. Out of the 160 subjects examined, 116 (72.5%) subjects presented with RMCs. It was found that 44 out of 72 males (45%) and 72 of 88 (68%) females presented with retromolar canals. Type B was the most common type. Based on the results of this study, retromolar canal should be considered as a normal anatomic variation rather than a rare finding. CBCT is suggested for a detailed evaluation and identification of the course of RMC before any surgical procedures to avoid post-operative complications. Very few studies have been conducted in Indian population and this study analysed the incidence of the RMC using CBCT images of South Indian population.

Key words: RMC – Cone beam computed tomography – Mandibular canal – Third molar

INTRODUCTION
Anatomical variations may influence predisposition to clinical examination, investigation and patient management. Inability to recognise the anatomical alterations may result in a fatal complication. Such an anatomical variation is RMC. RMC is an unusual anatomic variant in the retromolar triangle, which is a tiny triangular-shaped area in the jaw posterior to the third molar tooth following a course, and curves in posterosuperior direction to open into the retromolar fossa. It comprises neurovascular bundles which provide innervation to third molars. (Patil et al., 2013) Olivier postulated two types of inferior alveolar nerve (IAN) main trunk arrangements based on

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Submitted: May 6, 2022. Accepted: August 13, 2022

https://doi.org/10.52083/RAKK7944
A CBCT study on anatomic variations of retromolar canal

50 mandible dissections in 1927 (Olivier, 1928). Type I: the dental branches emerge from the undivided trunk just posterior to the roots that would supply the teeth (66 percent). Type II: The nerve divides into two sections shortly after entering the mandibular canal; a larger mental branch leaves the mandible at the mental foramen without providing any dental branches to the teeth, while a smaller branch forms a plexus and supplies the teeth (34 percent). According to the research in the late 1980’s Ossenberg et al. (1987) identified three different patterns of RMCs due to inadequate fusing of distinct mandibular canal nerves from the incisors, primary molars, and permanent molars during embryonic development. (Kawai et al., 2012; Von Arx et al., 2011; Lizio et al., 2013). The evaluation of the RMC is required to minimize traumatization of the contents of this canal during tooth extraction, bone harvesting procedures, and implant insertion (Jablonski et al., 1985; Pannalal et al., 2021; Kikuta et al., 2018). Cone beam computed tomography (CBCT) made substantial effect on determining RMC than other imaging modalities. (Han et al., 2014). Only a very few studies discussed the RMC evaluation in the Indian population. This study used CBCT scans to impart knowledge about the frequency and prevalent type of retromolar canal course in the South Indian population.

MATERIALS AND METHODS

This is a cross sectional study of subjects who had undergone CBCT examination of posterior mandible during the period of September 2020 to September 2021 from the Department of Oral medicine and radiology. Retrospective and prospective CBCT images were acquired and examined for the presence of RMCs. This study was approved by the Ethical Committee of the Institution (IEC protocol number: 96/2020).

CBCT Images of 160 patients aged between 21-86 years were selected by quota sampling method. CBCT images with optimum diagnostic quality showing retromolar regions were selected. Radiographs having posterior mandibular dental implants, those with clinical or radiographic signs of any pathologies, and those with a history of trauma to the posterior mandibular region and who had been treated with surgical intervention were all excluded. Images of the selected subjects were made using a Planmeca Promax 3D Mid CBCT machine. The tube voltage was set at 90 kVp, the tube current at 5.6 mA and the exposure time at 9.0 s. The height of the field of view (FOV) and the diameter both were 4 cm, and the voxel size was 0.08 mm. All RMCs evident on CBCT were included in the study irrespective of their diameter. The visibility of the retromolar area scan slice was inspected bilaterally in all three sections (sagittal, coronal, axial). All measures were assessed twice by both examiners, with a one-week break between each measurement. The inter- and intra-examiner reliabilities were assessed using Cohen’s kappa by examining 10% of the subjects by both the examiners in each survey. The kappa values for the inter- and intra-examiner reliability was 0.82-0.88.

Eventually, RMC was classified into three groups for the purpose of the study – A, B, C based on its origin, course, and relationship to the coronal region of the third molar and the retromolar fossa.

Based on the hypothesis of Patil et al. (2013), RMC was classified into the following three types:

- Type A: RMC branched off the mandibular canal distal to the 3rd molar and proceeded superiority to open into the retromolar fossa.
- Type B: canals ran between the retromolar fossa and the radicular part of the third molar.
- Type C: the canal originated from the mandibular foramen in the ramus region, coursed anteroinferiorly and then anterosuperiorly to open into the retromolar fossa.

Statistical analysis

The data were recorded into a Microsoft Office Excel Sheet (version 2019) and analyzed with the Statistical Package for Social Sciences (SPSS 22.0) A comparison of gender and age groups was made. To determine whether there was a statistically significant difference between the means in groups, descriptive statistics, and Pearson Chi-Square tests were applied to the data. Kappa statistics was adopted to determine the inter and intra examiner reliability in assessment of RMC.
RESULTS

Of the 160 subjects examined, 116 (72.6%) subjects presented with RMCs, among which 78 (48.8%) subjects presented with unilateral RMC and 38 (23.8%) presented with bilateral RMC. On comparing both genders it was found that 44 out of 72 males and 72 out of 88 females presented with RMCs. Hence females had higher incidence on statistical comparison among the genders in occurrence of RMCs and were found to be statistically significant. (p=0.00) (Table 1).

Table 1. Distribution of subjects among genders with unilateral/bilateral occurrence of retromolar canals.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Unilateral</th>
<th>Bilateral</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALE</td>
<td>30(41.7%)</td>
<td>14(19.4%)</td>
<td>28(38.9%)</td>
</tr>
<tr>
<td>FEMALE</td>
<td>48(54.5%)</td>
<td>24(27.3%)</td>
<td>16(18.2%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>78(48.8%)</td>
<td>38(23.8%)</td>
<td>44(27.5%)</td>
</tr>
</tbody>
</table>

The distribution of subjects with different types of RMCs based on age groups is described in Tables 2, 3. The most common type of RMC in male is type B (30.6%), followed by type A (11.1%) and type C (2.8%). The common type of RMC in female is type B (31.8%), followed by type A (11.4%) and type C (2.3%). The difference in distribution of RMC among gender was found to be statistically significant (p=0.00).

Among different age groups on the right side, type B was the most common in patients aged 20-30 years (29.7%), in 31-40 years (26.7%), in 41-50 years (44.4%), in 51-60 years (35.7%). Patients aged above 60 years had both type A and Type B in equal incidence in our study (Figs. 1, 2). Type C (Fig. 3) was the least common type occurred in different age groups. Among different age groups on left side, type B was the most common in patient aged 20-30 years (40.5%), in 31-40 years (40.0%), in 41-50 years (22.2%), in 51-60 years (35.7%).

Table 4 depicts the bilateral distribution of RMC among gender. Among males, combination types A+B (50.0%) and B+C (50.0%) had equal incidence. Type B+C had higher incidence in females (77.8%). Type A+C was found only in males in our study. Other combination patterns, such as A+A, B+B, and C+C, include the remaining frequencies. Table 5 shows the prevalence of retromolar canal in different populations, as published in previous studies.
A CBCT study on anatomic variations of retromolar canal

Fig. 1.- Sagittal section of CBCT illustrating Type A- retromolar canal branched off the mandibular canal distal to the 3rd molar and proceeded superiorly to open into the retromolar fossa.

Fig. 2.- Sagittal section of CBCT illustrating Type B- canals ran between the retromolar fossa and the radicular part of the third molar.

Fig. 3.- Sagittal section of CBCT illustrating Type C-the canal originated from the mandibular foramen in the ramus region, coursed anteroinferiorly and then anterosuperiorly to open into the retromolar fossa.
DISCUSSION

The RMC is an anatomic variation that originates behind the third molar in the mandibular canal and goes anterosuperiorly to the retromolar foramen (RMF) in the retromolar fossa (Fig. 4). Carter et al. (1971) discovered that the IAN or the retromolar branch that travels through the RMC give rise to a neural branch to the mandibular molars. However, Jablonski et al. (1985) identified an aberrant buccal nerve arising from the IAN within the mandible’s ramus, travelling through the RMC, emerging through the RMF, and then continuing forward and upward to penetrate the buccinator muscle. On CBCT research, RMC is now highly recognized. The RMC, however, comprises the retromolar nerve, which is a normal branch of the IAN, as revealed in prior anatomical investigations. Iwanaga et al. (2022) in their study concluded that RMC should be regarded the typical anatomy or normal variant of the inferior alveolar canal. However, few other researchers in their studies concluded that RMC is a branch of inferior mandibular canal. (Naitoh et al., 2009; Langlais et al., 1985). But still there exists a controversy in differentiating the mandibular canal and RMC and hereby in our study we suggest a word forum for consensus in support of the various literatures that are tabulated in Table 5.

Myelinated nerve fibers are present, along with multiple venules and an artery confirmed by histopathological examinations. During embryologic development, three different mandibular canals appeared in each hemimandible, and from each canal different inferior dental nerves emerged and innervated the three mandibular regions, according to an anthropological study by Chavez et al. (1996). These three canals combine to form a single canal during the fetal growth period of bone remodeling and apposition. Bifurcation or trifurcation is an anatomical variation caused by incomplete union of these three channels.

Anatomical variations such as the supplemental foramen, which acts as an escape route for the impulse to transmit pain, were noted by Rood (1976)

Table 5. Prevalence of retromolar canal in different populations as reported in previous studies.

<table>
<thead>
<tr>
<th>AUTHOR</th>
<th>YEAR</th>
<th>POPULATION</th>
<th>NUMBER OF SUBJECTS</th>
<th>% PREVALENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patil et al.</td>
<td>2013</td>
<td>JAPAN</td>
<td>171</td>
<td>75.4</td>
</tr>
<tr>
<td>Lizio et al.</td>
<td>2013</td>
<td>ITALY</td>
<td>233</td>
<td>14.6</td>
</tr>
<tr>
<td>Muinelo-Lorenzo et al.</td>
<td>2014</td>
<td>SPAIN</td>
<td>225</td>
<td>36.8</td>
</tr>
<tr>
<td>Han and Hwang</td>
<td>2014</td>
<td>SOUTH KOREA</td>
<td>446</td>
<td>8.5</td>
</tr>
<tr>
<td>Rashsuren et al.</td>
<td>2014</td>
<td>SOUTH KOREA</td>
<td>755</td>
<td>11.5</td>
</tr>
<tr>
<td>Sisman et al.</td>
<td>2015</td>
<td>TURKEY</td>
<td>947</td>
<td>26.7</td>
</tr>
<tr>
<td>Iwanaga et al.</td>
<td>2016</td>
<td>IRAN</td>
<td>179</td>
<td>12.8</td>
</tr>
<tr>
<td>Ahuja et al.</td>
<td>2018</td>
<td>INDIA</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>Badry et al.</td>
<td>2020</td>
<td>EGYPT</td>
<td>214</td>
<td>11.2</td>
</tr>
<tr>
<td>Oliveira de Gringo</td>
<td>2021</td>
<td>BRAZIL</td>
<td>200</td>
<td>24.5</td>
</tr>
<tr>
<td>Present Study</td>
<td>2022</td>
<td>INDIA</td>
<td>160</td>
<td>72.5</td>
</tr>
</tbody>
</table>

Fig. 4. CBCT sagittal section showing retromolar canal.
in a case of failure to attain mandibular anesthesia. Some writers have also documented failures in attaining mandibular anesthesia and the existence of a bifid mandibular canal on radiological examination. For the categorization of RMCs in this study, we used Patil et al. (2013) approach. It proved to be the most practical categorization. The type B canal that begins at the RMF and terminates in the radicular section of the 3rd molar was not included in Ossenberg (1987) or Jamalfour et al. (2016) classifications.

**CONCLUSION**

In conclusion, knowledge of this anatomical variance and its assessment before surgery involving the posterior mandible like extraction of an impacted third molar, bone harvesting as a donor site for bone graft surgery and sagittal split osteotomy may warn the clinician about possible inadequate pre-surgical anesthesia, unexpected bleeding or local altered sensation post-operatively through damage to the vessels and nerves through the RMC. It is, therefore, important to confirm the course and location of the RMC prior to surgical procedures. Since there is no comprehensive study that includes all types of retromolar canals in the Indian population, this study can be considered as the standard incidence of the RMC using CBCT images of South Indian population.

**REFERENCES**


