Evaluation and Incidence of Retromolar Canal with CBCT in Adult Population-A Retrospective Study.

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Abstract:
The Retromolar canal branches off the main mandibular canal. A RMC includes neurovascular bundles, which consist of arteries, numerous venules, and myelinated nerve fibers. Oral and Maxillofacial Surgery cases in the Retromolar area have been increasing. Therefore, it is important to confirm the presence and location of a RMC before surgical procedures in the mandible. Recently, high-resolution Cone-Beam Computed Tomography (CBCT) has become notably effective for confirming anatomical variations of the mandibular canal.
A study was conducted to assess the incidence, morphology and location of the Retromolar canal in adult population using cone beam computed tomography (CBCT) and clinical application of same in management of surgical procedures. In our study, CBCT images of 100 subjects were evaluated. Analysis regarding age and gender- specific data was also carried out. In the event of presence of Retromolar canal on CBCT, they were further classified according to the course and morphology in several categories.
In our study incidence of the Retromolar canal in CBCT images was 12%. The left side was involved more than right side. The majority of Retromolar canals type in the present study was type B1 category, followed by type A and type C.
Key words: Cone Beam Computed Tomography (CBCT), Retromolar Canal (RMC)

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INTRODUCTION

The Retromolar canal (RMC) branches off the main mandibular canal and follows a recurrent path, curving in a posterosuperior direction behind the third molar to open into the Retromolar foramen.[1]The Retromolar foramen (RMF) is the opening of a RMC found in the Retromolar trigone, posterior to the last molar.[1]A RMC includes neurovascular bundles, which consist of arteries, numerous venules, and myelinated nerve fibers.[2]However, the elements of a RMC have not yet been defined. The canal may conduct accessory innervations to the mandibular molars or can even contain aberrant buccal nerves. [3]

The studies of the RMC using panoramic radiography have reported occurrence rates of less than 1%, so the canal has been considered a rare anatomical variation.[4]Recently, high-resolution

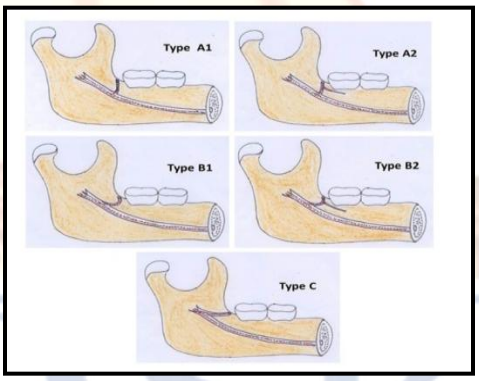
Cone-Beam Computed Tomography (CBCT) has become notably effective for confirming anatomical variations of the mandibular canal that cannot be assessed on panoramic radiographs.[5] Recently, dental surgery cases such as dental implants, the surgical extraction of an impacted mandibular third molar, sagittal split ramus osteotomy, and bone block harvesting in the Retromolar area have been increasing.[5] Therefore, it is important to confirm the presence and location of a RMC prior to surgical procedures in the mandible. Identifying these anatomic structures has important clinical implications. It may help in avoiding some of the complications resulting from injury of RMC during surgery, such as paraesthesia, sensory disturbances, traumatic neuromas & unanticipated profuse bleeding.[5,6] Moreover, proper identification of RMCs may help adequate planning of anaesthesia.[7,8]

MATERIALS AND METHODS:

This study was carried out for the duration of 24 months from 2015 to 2017 at the Department of Oral and Maxillofacial Surgery. All patient who was ordered CBCT as an investigation modality for further management or any operative dental procedure and willing for being part of the study. Patients were referred for CBCT scan following a preliminary diagnosis. All the CBCT images in archives were evaluated and included in the study if they are eligible. The CBCT images of patients with history of dysplasia, cystic and neoplastic lesion were excluded from the study. In addition, some images with a low field of view were excluded from the study if they did not cover the Retromolar area. Furthermore, images with motion artefact were excluded because of low images quality. Overall 100 patients (200 sides) images were evaluated based on inclusion and exclusion criteria.

CBCT images were viewed on the computer screen and reformatted into multiplanar reconstruction to achieve the most appropriate section for assessment and taking measurement whenever necessary. Maxillofacial surgeon along with oral radiologists was evaluated the CBCT images to examine for the presence or absence of the mandibular Retromolar canal and foramen.

Axial, sagittal and cross-sectional images were reconstructed, and 3D reconstructions were used when necessary. The CBCT scan was analysed for incidence and laterality of Retromolar canal. Analysis regarding age and gender-specific data was carried out. In the event of the presence of RMC on CBCT, they were further classified according to the course and morphology in several categories. Based on the course and morphology using the **Thomas von Arset** classification, the recorded RMC were classified into five types **[Figure 1].**The Vertical course of the Retromolar canal (Type Al),a vertical course of the Retromolar canal with horizontal branch (Type A2), Curved course of the Retromolar canal (Type B1), Curved course of the Retromolar canal with additional a horizontal branch (Type B2), Horizontal course of Retromolar canal (Type C).



Type A1 - Vertical course of the Retromolar canal.
Type A2 - Vertical course of the Retromolar canal with horizontal branch.
Type B1 - Curved course of the Retromolar canal.
Type B2 - Curved course of the Retromolar canal with additional horizontal branch.
Type C - Horizontal course of Retromolar canal.

Figure 1: Schematic illustration showing different configuration of Retromolar canal. [Von Arx et al. (2011)]

RESULTS:

200 slides (100 right + 100 left) in 100 CBCT scans were used to assess the incidence and clinical course of Retromolar canals. A total of 12 Retromolar canals were detected with CBCT images **[Table 1].**7 (58.33%) scans showed the presence of RMC on the right side, 5 (41.66%) scans showed the presence of RMC on the left side **[Table 1]**.

	Unilateral		Bilateral	Total
	Right	Left		
RMCs Identified	7	5	0	12
Number of scans in which RMC was identified	12		0	12

Table 1: Unilateral and bilateral appearance of Retromolar canal

About gender, men tended to have a Retromolar canal more often than women in the present study, but no statistical difference was found. Of the seven RMC [58.33%] noted in male, three were on right side and four were on left side. Of the 5 RMC [41.66%] noted in a female, on right side two and on left side three RMC were identified. In age group (18-25 yr) 20 subjects were examined of which two scans were with RMC **[Table 2].**

	Right side		Left side		Total
	Male	Female	Male	female	
CBCTs with a Retromolar canal	3	2	4	3	12
Percentage of CBCTs showing a Retromolar canal	25.00 %	16.66 %	33.33 %	25.00 %	100 %

Table 2: Gender distribution of identified Retromolar canal

In age group (26-30 yr) 20 subjects & 3 RMCwere present. In age group (31-35 yr) 14 subjects were examined with two positive scans withRMC. In age group (36-40 yr) 12 subjects were examined & 1 RMC was present. In agegroup (41-45 yr) 18 subjects were examined with two positive RMC. In age group (46-50 yr) 16subjects were examined & 2 RMC were present**.** Overall age group 26- 30 yrs were havinghighest number,i.e. 3 RMC**[Table 3].**

Age groups	No. Of subjects examined	No. of subjects with retromolar canals
18-25	20	2
26-30	20	3
31-35	14	2
36-40	12	1
41-45	18	2
46-50	16	2
Total	100	12

Table 3: Distribution of Retromolar canals based on age

About canal morphology, the most common type was B1; Type B1 was present in 8 out of 12 RMC corresponding to 66.67%. The second most common type was type A1 which was found in 2 of 12 RMC (16.7%). This was followed by 1 (8.3%) RMC of each type A2 and type C. Surprisingly none of our patients were having type B2 canal **[Table 4].**

Sides	No of sides in which RMC was seen	A1	A2	B1	B2	C
Right side	7	1	0	5	0	1
Left side	5	1	1	3	0	0
Total	12	2	1	8	0	1

Table 4: Side distribution showing types of RMC

The mean height of the canal (vertical distance from Retromolar foramen to the mandibular canal) was 11.33 mm ± 2.35 mm (range 7.42–18.16 mm). Linear regression analysis demonstrated gender as a significant factor (P = .024), with men having higher values than women (mean difference, 2.05 mm). The mean diameter of the Retromolar canal measured at 3 mm below the Retromolar foramen was 0.98 mm ± 0.30 mm (range 0.49–1.74mm). No significant differences were found for age (P = 0.520) and gender (P = 0.446) **[Table 5].**

	Mean ± SD	Range	95% CI
Horizontal distance from midpoint of Retromolar foramen to the second molar	15.15 ± 2.39 mm	12.31–22.31 mm	14.27–16.02 mm
Height of Retromolar canal	11.33 ± 2.35 mm	7.42–18.16 mm	10.46–12.20 mm
Width of Retromolar canal	0.98 ± 0.30 mm	0.49–1.754 mm	0.86–1.09 mm

Table 5: Linear Measurements of the Retromolar Canals

The mean distance from the midpoint of the Retromolar foramen to the distal aspect of the second molar (CEJ) was 15.15 mm ± 2.39 mm (range 12.31–22.31 mm). The linear regression analysis identified age as a statistically significant factor (P = 0.06), with younger patients having a longer distance (a 10-year increase in age was associated with a reduction of that distance by 0.88 mm)**[Table 5]**

DISCUSSION:

CBCT-based studies in literature arrived at deviating values about incidence of Retromolar canal i.e. incidence of 14.6% in 233 sides evaluated by **Lizio et al.[8],** 25.6% in 121 sides by **Von Arx et al.[9]**, 37% in 90 sides by **Kawai et al.[10]** and 65.3% in 254 sides by **Patil et al.[11]**

Sismanet al.[12]compared CBCT and OPG images and found a total of 253 RMCs (144 left, 109 right) detected with CBCT images (26.7%). Only 29 of these canals were also seen on the corresponding panoramic radiographs. In our study Out of 100 CBCT scans, that were analyzed for the presence of RMC. 12 scans showed the occurrence of RMC corresponding to the incidence of 12%. Differences in various studies can be attributed to deviating sizes of the study populations, varying definitions of the RMC, different methods of measurement and deviating interpretations of the images on CBCT.

Regarding laterality and sex distribution **Capote TS et al.[13]**reported that there was no significant association between the presence of the RMC and sex on the right and left sides. **Thomas von Arx et al[9]**reportedmore women than men and more left sides than right sides tended to have Retromolar canals, but these differences did not reach statistical significance. Of the 21 cases with bilateral evaluation, only 4 (19%) presented with a Retromolar canal on both sides.**Ossenberget al.[1]**reported a slightly greater incidence of the Retromolar foramen in males, but without reaching statistical significance. In the study done by **Seema Patilet al.[11]** 58 of 77 males and 71 of 94 females presented with Retromolar canals and hence, no difference in the occurrence of Retromolar canals about gender was evident. Sixty-four of the 88 subjects with unilateral examination and 65 of the 83 subjects with bilateral examination presented with Retromolar canals. The difference in the occurrence of Retromolar canals between the right and left side of the mandible in both unilateral and bilateral category was not significant statistically. In our study, none of the scans showed the occurrence of RMC bilaterally. Out of 12 CBCT which were positive for RMC, 7 (58.33%) scans showed the presence of RMC on the right side, 5 (41.66%) scans showed presence of RMC on the left side. About gender, men tended to have a Retromolar canal more often than women in the present study, but no statistical difference was found. Of the 7 RMC [58.33%] noted in male, three were on the right side, and four were

on the left side. Of the 5 RMC [41.66%] noted in female, on right side 2 and on left side 3 RMC were identified.

Concerning occurrence of the Retromolar foramen concerning age, in age group (18-25 yr) we examined 20 subjects of which two scans were with RMC. In age group (26-30 yr) 20 subjects & 3 RMC were present. In age group (31-35 yr) 14 subjects were examined with two positive scans with RMC. In age group (36-40 yr) 12 subjects were examined & 1 RMC was present. In age group (41-45 yr) 18 subjects were examined two positive RMC. In age group (46-50 yr) 16subjects were examined &two RMC were present**.** Overall age group 26- 30 yrs were having highest number,i.e. 3 RMC.

Different authors have defined specific anatomical courses to predict the course of RMC mentioning specific classification about canal morphology. They have a varied classification, but similar in structure. **Ossenberget al.**[1]gave the first description of the type of Retromolar canals based on their course and described in three patterns. **[Fig 2]**

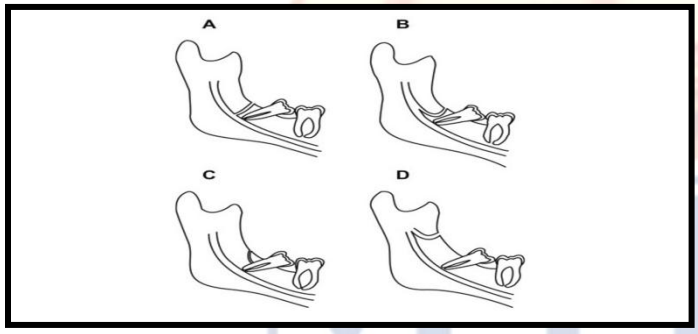


Figure 2: Schematic representation of different configuration of Retromolar canal. [Ossenberg et al. (1987)]

Thomas Von Arset al.[9] found that most Retromolar canals had a vertical course (type Al, 41.9%) or were slightly curved (type B1, 29.0%). Type C, a horizontal course, was never identified.**[Fig.1] Katharina Filo et al.**[14] found 86 (39.82%) corresponding to type Al, 41 (18.98%) typeA2, 52 (24.07%4) to type B1, 24 (11.11%) to type B2, and 13 (6.02%) to type C out of 216RMC identified using Von Arx classification.**Patil et al.**[11]found 129 subjects with Retromolar canals included 19 subjects with type A pattern, 97 subjects with type B pattern, 12 subjects with both types A and B patterns and one subject with types B and C patterns.**[Fig.3]**

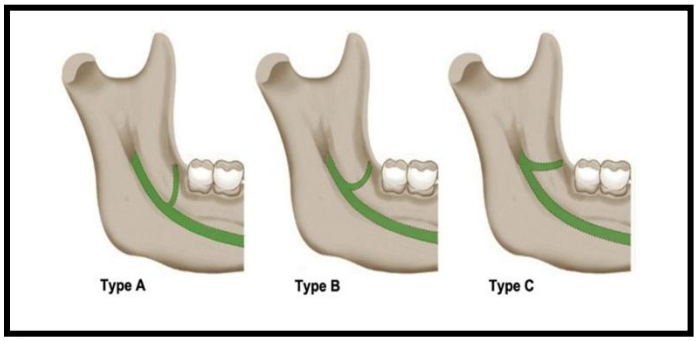


Figure 3: Schematic representation of different configuration of Retromolar canal. [Patil et al. (2013)]

In our study, we have used classification by **Thomas Von arx (2011)** for identifying the course of RMC. We found that of the 12 CBCT with Retromolar canal. The most common type was B1. Type B1 was present in 8 out of 12 RMC corresponding to 66.67%. The second most common type was type A1 which was found in 2 of 12 RMC (16.7%). This was followed by 1 (8.3%) RMC of each type A2 and type C. Surprisingly none of our patient had B2 canal.

Narayana et al.[5]reported widths ranging from 1.5mm–4.35 mm for the Retromolar canal, but without specifying the level of measurement. The mean distance from the midpoint of the Retromolar foramen to the distal aspect of the second molar (CEJ) was 15.15 mm ± 2.39 mm (range 12.31–22.31 mm). The linear regression analysis identified age as a statistically significant factor (P = .061).The mean height of the canal (vertical distance from Retromolar foramen to the mandibular canal) was 11.33 mm ± 2.35 mm (range 7.42–18.16 mm). Linear regression analysis demonstrated gender as a significant factor (P = 0.024), with men having higher values than women (mean difference: 2.05 mm). The mean diameter of the Retromolar canal measured at 3 mm below the Retromolar foramen was 0.98 mm ±0.30 mm (range 0.49–1.74mm). No significant differences were found for age (P = 0.520) and gender (P = 0.446), which is comparable with the study by **Thomas Von Arxet al**.[9]

It has been observed that the neurovascular bundle of foramen originated in the mandibular canal. We would also like to stress upon penetration of the neurovascular bundle in to the distal lamina dura of the distal root of the third molar. The clinician should be aware of this accessory innervation provided by RMC in the endodontic treatment. Postoperative hematomas caused by damage to the contents of canal and foramen during a surgical procedure or implantation should be kept in mind. The accessory innervations of an RMC may result in local anaesthetic insufficiency during routine dental procedures using conventional nerve block techniques. So, it is advisable to perform a higher anaesthetic technique, such as the Gow-Gatesblock or other high pterygoid entry injection.

Since the foramina of RMCs in the Retromolar area were recorded only 12 mm apart from the distal aspect of the second mandibular molar in this study, it was hypothesized that an injury to the RMC was often unavoidable during the routine incision for detaching the vestibular flap in the retromolar area. The damage to an RMC may result in unilateral paraesthesia of the buccal sulcus and gingiva from the retromolar area to the canine region, excessive bleeding, postoperative hematoma, or traumatic neuroma.To avoid it, distal incision should be taken laterally instead of taking it over ramus or lingually, according to our study. Also the supplemental canal may be a route for the spread of a tumour or for infection that may interfere with implant insertion and any prosthetic restoration or implants located distal to the Retromolar area can lead to paraesthesia and pain.

CONCLUSIONS

The present study demonstrated the presence of a Retromolar canal in 12% of CBCTs .Age, gender, and side did not statistically affect the presence of the Retromolar canal. The interesting and clinically relevant aspect of the retromolar canal is the fact that it conveys accessory innervation to the most posterior region of the alveolar process, including the mandibular molars, but it might also contain an aberrant buccal nerve. In the event of anaesthetic failure (mandibular block), the clinician is advised to consider the neural elements of the Retromolar canal as a possible cause.

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