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 anatomical 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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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 superiorly 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.

	Unilateral	Bilateral	Absent
MALE	30(41.7%)	14(19.4%)	28(38.9%)
FEMALE	48(54.5%)	24(27.3%)	16(18.2%)
TOTAL	**78(48.8%)**	**38(23.8%)**	**44(27.5%)**

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.

Table 2. Distribution of types of RMC in different age on right side.

TYPE	20-30YR	31-40 YR	41-50YR	51-60 YR	ABOVE 60
A	10(13.5%)	4(13.3%)	0	2(7.1%)	2(20.0%)
B	22(29.7%)	8(26.7%)	8(44.4%)	10(35.7%)	2(20.0%)
C	2(2.7%)	2(6.7%)	0	0	0
TOTAL	**74**	**30**	**18**	**28**	**10**

Table 3. Distribution of types of RMC in different age on left side.

TYPE	20-30YR	31-40 YR	41-50YR	51-60 YR	ABOVE 60
A	8(10.8%)	4(13.3%)	2(11.1%)	0	0
B	30(40.5%)	12(40.0%)	4(22.2%)	10(35.7%)	4(40.0%)
C	4(5.4%)	2(6.7%)	2(11.1%)	0	0
TOTAL	**74**	**30**	**18**	**28**	**10**

Table 4. Distribution of bilateral type of RMC among gender.

	A+B	B+C	A+C
MALE	4(33.3%)	4(22.7%)	2(100.0%)
FEMALE	8(66.7%)	14(77.8%)	0
TOTAL	**12(100.0%)**	**18(100.0%)**	**2(100.0%)**

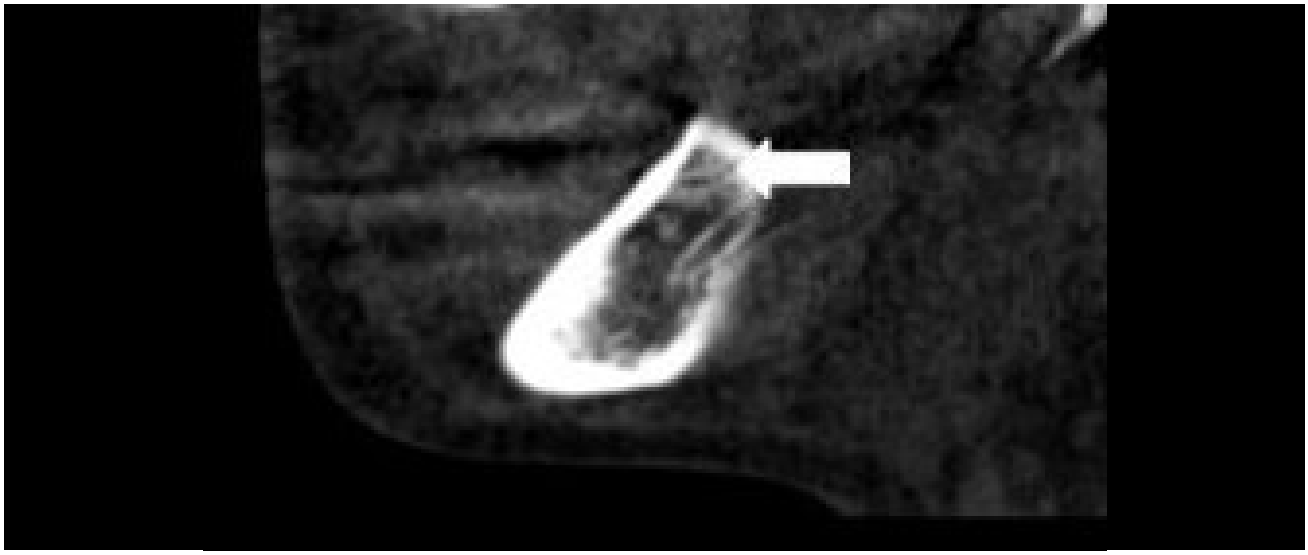

Fig. 1.- Sagittal section of CBCT illustrating Type A- retromolar canal branched off the mandibular canal distal to the 3rd molar and proceeded superiorly to open into the retromolar fossa.

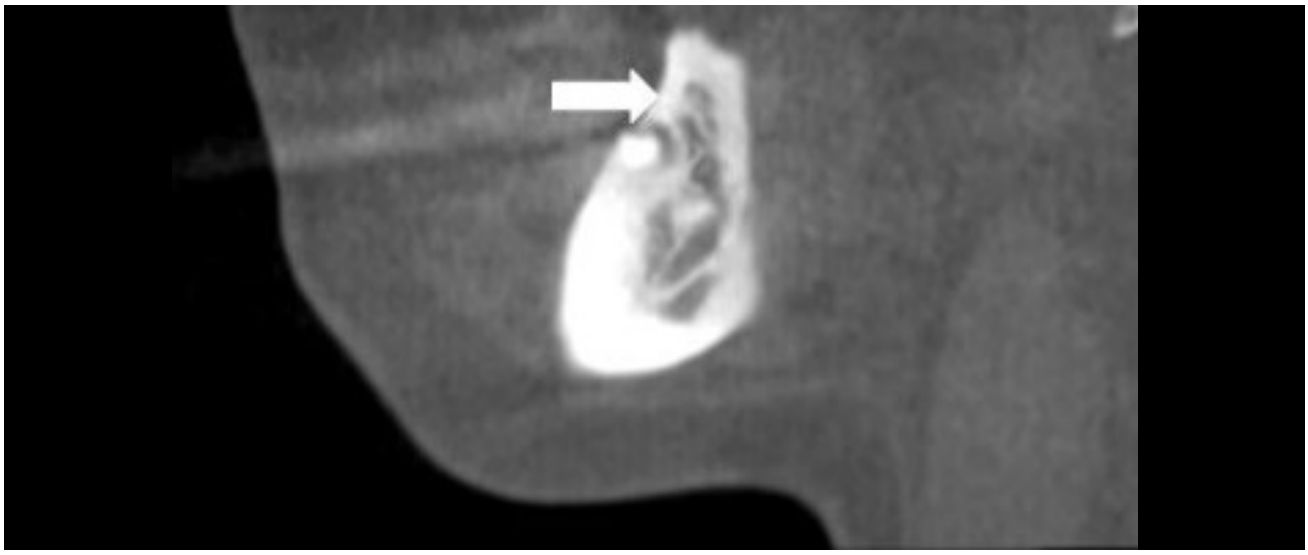

Fig. 2.- Sagittal section of CBCT illustrating Type B- canals ran between the retromolar fossa and the radicular part of the third molar.

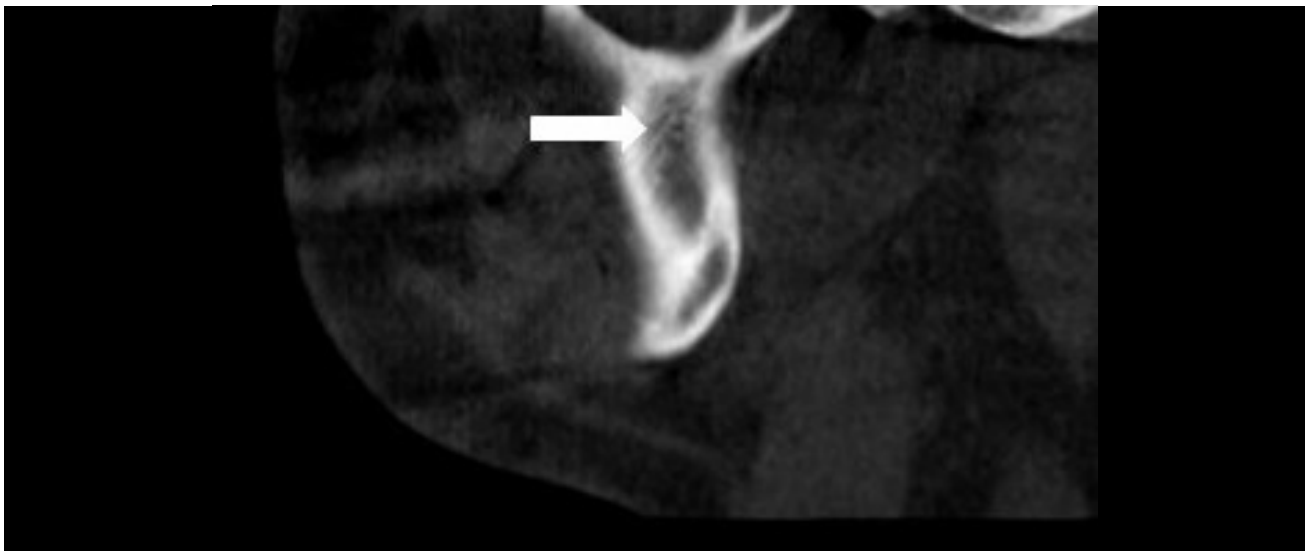

Fig. 3.- Sagittal section of CBCT illustrating Type C-the canal originated from the mandibular foramen in the ramus region, coursed anteroinferiorly and then anterosuperiorly to open into the retromolar fossa.

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

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

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.

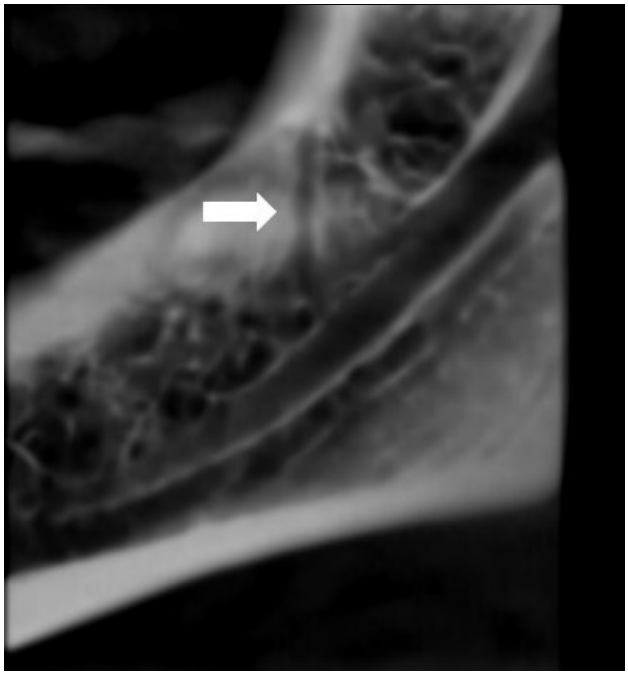

Fig. 4.- CBCT sagittal section showing retromolar canal.

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)

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 Jamalpour 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

AHUJA SB, BHARDWAJ NS, DANG V, AHUJA R, MATHUR H (2018) Prevalence of RMC and foramen: A cone beam computed tomography study. *J Indian Acad Oral Med Radiol.* 30: 216-222.

BADRY MSM, EL-BADAWY FM, HAMED WM (2020) Incidence of retromolar canal in Egyptian population using CBCT: a retrospective study. *Egypt J Radiol Nucl Med*, 51: 46.

CHAVEZ ME, MANSILLA J, POMPA JA, KJAER I (1996) The human mandibular canal arises from three separate canals innervating different tooth groups. *J Dent Res*, 75: 1540-1544.

CAROLINE PAULA OLIVEIRA DE GRINGO, EYMI VALERY CAZAS DURAN DE GITTINS, CÁSSIA MARIA FISCHER RUBIRA (2021) Prevalence of RMC and its association with mandibular molars: study in CBCT. *Surg Radiol Anat*, 43: 1785-1791.

CARTER RB, KEEN EN (1971) The intramandibular course of the inferior alveolar nerve. *J Anat,* 108: 433-440.

FREITAS D, DE FREITAS SILVA GB, ALESSANDRA M, ALEXANDRE FS, DA SILVA MB, GOMES TC (2015) Incidence and classification of bifid mandibular canals using cone beam computed tomography. *Braz J Oral Sci*, 14: 294-298.

HAN SS, HWANG YS (2014) Cone beam CT findings of RMCs in a Korean population. *Surg Radiol Anat*, 36: 871-876.

IWANAGA J, TAKESHITA Y, MATSUSHITA Y, HUR MS, IBARAGI S, TUBBS RS (2022) What are the retromolar and bifid/trifid mandibular canals as seen on cone-beam computed tomography? Revisiting classic gross anatomy of the inferior alveolar nerve and correcting terminology. *Surg Radiol Anat,* 44: 147-156.

JABLONSKI NG, CHENG CM, CHENG LC, CHEUNG HM (1985) Unusual origins of the buccal and mylohyoid nerves. *Oral Surg, Oral Med, Oral Pathol,* 60(5): 487-488.

JAMALPOUR M, SHOKRI A, FALAH-KOSHKI S, ZAVAREIAN A (2016) Evaluation of RMCs with cone-beam computed tomography in an Iranian adult population: a retrospective study. *Int J Clin Dentist*, 9(4): 233-240.

KIKUTA S, IWANAGA J, NAKAMURA K, HINO K, NAKAMURA M, KUSUKAWA J (2018) The RMCs and foramina: radiographic observation and application to oral surgery. *Surg Radiol Anat,* 40(6): 647-652.

KAWAI T, ASAUMI R, SATO I, KUMAZAWA Y, YOSUE T (2012) Observation of the retromolar foramen and canal of the mandible: a CBCT and macroscopic study. *Oral Radiol*. 28: 10-14.

LANGLAIS RP, BROADUS R, GLASS BJ (1985) Bifid mandibular canals in panoramic radiographs. *J Am Dent Assoc,* 110: 923-926.

LIZIO G, PELLICCIONI GA, GHIGI G, FANELLI A, MARCHETTI C (2013) Radiographic assessment of the mandibular RMC using cone-beam computed tomography. *Acta Odontol Scand,* 71: 650-655.

MAHMOUD SAYED, MAHMOUD BADRY, FATMA MOSTAFA EL-BADAWY, WALAA MOHAMED HAMED (2020) Incidence of RMC in Egyptian population using CBCT: a retrospective study. *Egyptian J Radiol Nuclear Med,* 51: 46.

MUINELO-LORENZO J, SUAREZ-QUINTANILLA JA, FERNANDEZ ALONSO A, MARSILLAS-RASCADO S, SUAREZ-CUNQUEIRO MM (2014) Descriptive study of the bifid mandibular canals and retromolar foramina: cone beam CT vs panoramic radiography. *Dentomaxillofac Radiol*, 43(5): 20140090.

NAITOH M, HIRAIWA Y, AIMIYA H, ARIJI E (2009) Observation of bifid mandibular canal using cone-beam computerized tomography. *Int J Oral Maxillofac Implants,* 24: 155-159.

OLIVIER E (1928) The inferior dental canal and its nerve in the adult. *Br Dent J,* 49: 356-358.

OSSENBERG NS (1987) Retromolar foramen of the human mandible. *Am J Physn Anthropol*, 72: 119-128.

ORHAN K, AKSOY S, BILECENOGLU B, SAKUL BU, PAKSOY CS (2011) Evaluation of bifid mandibular canals with cone-beam computed tomography in a Turkish adult population: A retrospective study. *Surg Radiol Anat,* 33: 501-507.

PATIL S, MATSUDA Y, NAKAJIMA K, ARAKI K, OKANO T (2013) RMCs as observed on cone-beam computed tomography: Their incidence, course, and characteristics. *Oral Surg Oral Med Oral Pathol Oral Radiol*, 115: 692-699.

PANNALAL V, DEOGHARE A, FATING C, JHA S, BIRANJAN R (2021) The elusive retromolar foramen and RMC: A CBCT study. *IP Int J Maxillofac Imaging*, 7(3): 118-124.

RASHSUREN O, CHOI J-W, HAN W-J, KIM EK (2014) Assessment of bifid and trifid mandibular canals using cone beam computed tomography. *Imaging Sci Dentist,* 44: 229-236.

ROOD JP (1976) The analgesia and innervation of mandibular teeth. *Br Dent J,* 140: 237-239.

TANTANAPORNKUL W, OKOUCHI K, FUJIWARA Y, YAMASHIRO M, MARUOKA Y, OHBAYASHI N (2007) A comparative study of cone beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 103: 253-259.

SISMAN Y, ERCAN-SEKERCI A, PAYVEREN-ARIKAN M, SAHMAN H (2015) Diagnostic accuracy of cone-beam CT compared with panoramic images in predicting RMC during extraction of impacted mandibular third molars. *Medicina Oral Patologia Oral y Cirugia Bucal,* 20: 74-81.

VON ARX T, HÄNNI A, SENDI P, BUSER D, BORNSTEIN MM (2011) Radiographic study of the mandibular RMC: an anatomic structure with clinical importance. *J Endod,* 237: 1630-1635.