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The retromolar foramen and canal in south Indian dry mandibles

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SUMMARY

The retromolar foramen (RMF) is one of the non-metrical variants of the mandible. A total of 53 (21.9%; N = 242) mandibles had the foramen; of these, 26 (10.7%) showed it only on the right side, 17 (7.1%) only on the left side, and 10 (4.1%) bilaterally. There was no side difference in this trait, and the distance between the foramen and other mandibular landmarks (anterior border of ramus, 3rd molar and lingula) did not show any side differences either ($p>0.05$). In 6 mandibles the retromolar canal was studied using the digital subtraction angiography technique. Mandibles 1 and 2 showed the vertical canal joining with the mandibular canal (Type I) bilaterally, and mandibles 3 and 5 showed type I only on the left side. Mandibles 3 only on the right side, 4 on both sides and 6 only on the left side showed the canal descending vertically and then coursing backwards to join the mandibular canal (Type II). Mandibles 5 and 6 only on the right side showed the canals descending to the mandibular canal, from the middle and anterior aspect of which another canal extended anteriorly superior to the mandibular canal (Type III). These canals showed variations in length and diameter. This study shows that the foramen and canal are highly variable in their morphology and morphometry, and they should be taken into account during anaesthetic, surgical, and implantation procedures of the mandible.

Key Words: Mandibular canal – Digital subtraction angiography – Accessory foramina – Inferior alveolar nerve

INTRODUCTION

The retromolar fossa is a triangular area posterior to the third mandibular tooth (McMinn, 1992). An opening called the retromolar foramen (RMF) is known to be present in this area (Ossenberg, 1987). Although the presence of this foramen is acknowledged (Soams, 1995), some anatomical textbooks do not mention its occurrence or anatomical details (Hollinshed, 1968; Anson and McVay, 1971; Basmajian and Slonecker, 1989; Romanes, 1991; McMinn, 1992). Sawyer and Kiely (1991) reported that the incidence of the RMF does not show differences as regards side or sex, but does have a positive correlation with the accessory mandibular foramen, regarding the same-side occurrence. This foramen extends as a retromolar canal (RMC) into the body of the mandible, and one such case was previously reported in a Japanese subject (Kondera and Hashimoto, 1995). Those authors reported the foramen and canal in 8 out of 41 Japanese mandibles and noticed branches from the inferior alveolar neurovascular bundle passing through the canal.

Kondera and Hashimoto (1995) observed the RMC in lateral cephalograms and reported that it is seen as a linear shadow with anterior and

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posterior radio-opaque borders. There are very few reports (Ossenberg, 1987; Kondera and Hashimoto, 1995) on the RMF and RMC and there are no studies that have employed contrast radiographs to describe the morphology of the canal. Since this canal is known to transmit the neurovascular bundle, its anatomy and variations are extremely important in surgical procedures that involve the mandible. Thus, the present study was designed to define the anatomy of the RMF and RMC in south Indian dry mandible.

Materials and Methods

In this study, 242 dry adult mandibles of unknown sex but of south Indian origin were employed. The bones were collected from medical students of Kasturba Medical College, Mangalore. All bones were observed independently by different authors. The RMF, when observed, was classified into <0.5mm and 0.5 or >0.5mm in diameter separately for either side. Distances from the RMF to the 3rd molar, to the anterior border of the ramus, and to the lingula were measured accurately to the closest millimeter.

RMCs were studied in 6 mandibles with an RMF of >0.5mm in diameter. It was not possible to study the same in other mandibles with RMF of >0.5mm diameter since the canals were blocked and hence the dye was unable to flow. The radio-opaque dye Angiograffin (65%, German Remedies) was injected through the RMF, and radiographs were obtained by Digital Subtraction Angiography (DSA) technique (GE OEC 9800, USA). In these x-rays, the morphology of the canal was studied. Following careful observation, the canals were diagnosed as belonging to 3 different types. Type I was a simple one, descending vertically to the mandibular canal (MC). The type II canal first descended and then coursed posteriorly and joined the MC. Type III canal descended vertically to the MC, but another canal traversed anteriorly from the anterior aspect. In x-rays, the size of the mandible was reduced to 66%. Hence to obtain the real measurements of the RMC a correction factor was calculated as follows. The correction factor was equal to the actual measurement/observed measurement, which was equal to 2.9. The real measurement was equal to the observed measurement x2.9

The side difference in the incidence of 2 types of RMF was compared using the Chi square test. Various measurements from the RMF to other landmarks were expressed as means ± SD and side differences were compared by the Mann-Whitney 'U' test.

Results

The RMF is found in the retromolar triangle with variable diameters. The foramen has a smooth opening facing upwards and backwards (Fig. 1). Of 242 mandibles, observed, 53 (21.9%) showed the RMF. Of these, 26 (10.7%) mandibles showed it only on the right side; 17 (7.1%) only on the left side, and 10 (4.1%) bilaterally. Among 26 right-sided RMF, 16 foramina had a diameter of <0.5mm and 10 with a diameter of > 0.5mm. Among the 17 foramina on the left side, 9 had a diameter < 0.5mm and 8 >0.5mm. Two mandibles had the bilateral foramina measuring >0.5mm in diameter and the remaining 8 mandibles, a combination of both. There was no side difference in this trait (χ^2 = 0.024; p = 0.8758). The distances from the different landmarks (Fig. 2) to the RMF also failed to show any side differences (P>0.05).

Table 1 shows the distribution of different types of RMCs in six mandibles studied. Two mandibles had the type I canal on either side and one mandible had the type II on either side. The remaining mandibles had a combination of different types. Table 2 shows the morphometric data of RMCs. The type I canal measured 11.6-20.3mm and then joined the MC (Fig. 3). In all cases, type I RMCs measured not more than 1.5mm in diameter. The length of vertical part of the type II canal ranged from 8.7-14.5mm and

Figure 1.- Photograph of a mandible showing bilateral RMF.

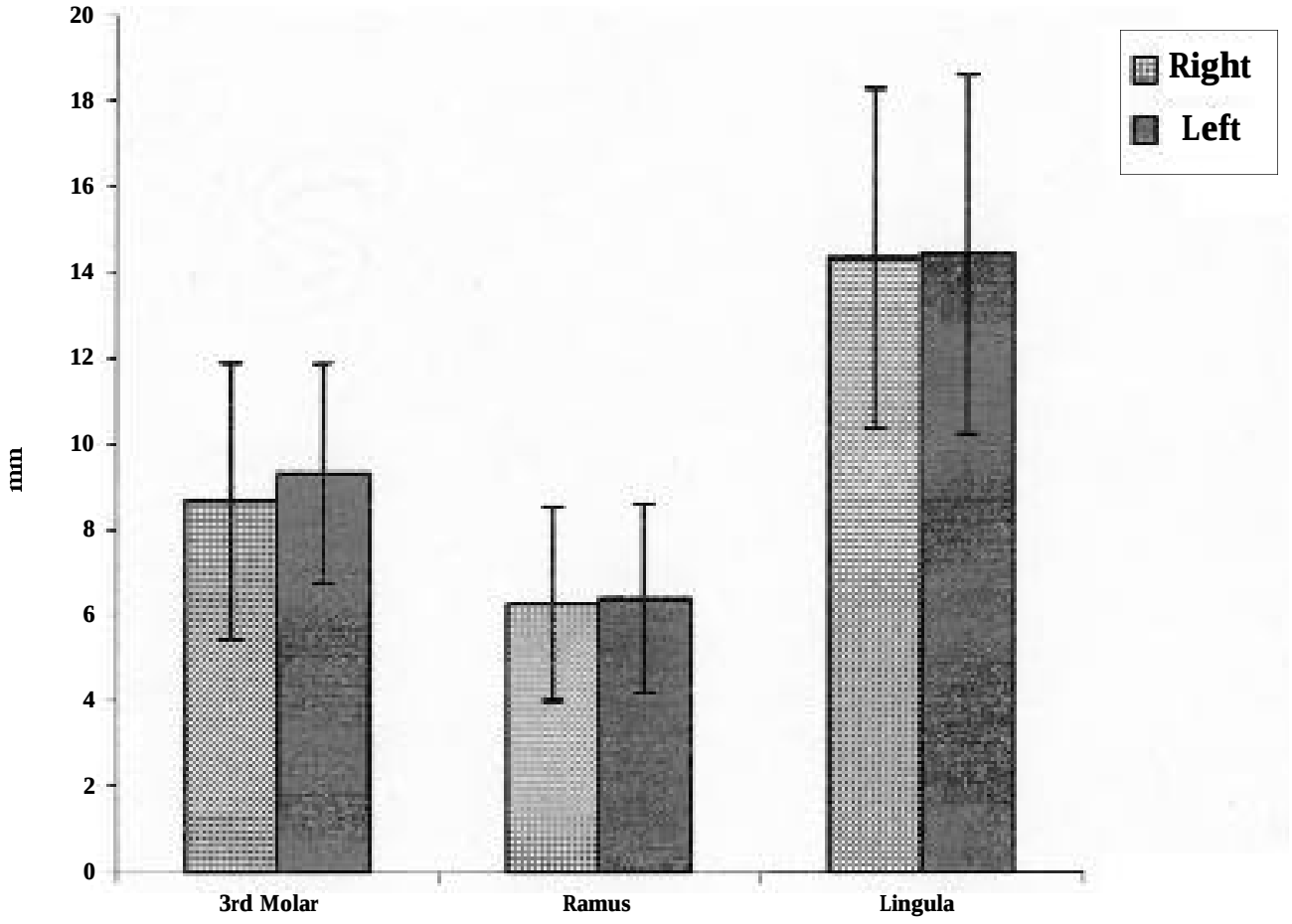

Figure 2.- Distances between three mandibular landmarks and the RMF[1].
[1] Mean ± SD from 20 measurements each. Differences are not significant between the sides (P>0.05).

Table 1.- Distribution of different types of RMC in 6 mandibles.

Serial number	Right side	Left side
Mandible 1	Type I	Type I
Mandible 2	Type I	Type I
Mandible 3	Type II	Type I
Mandible 4	Type II	Type II
Mandible 5	Type III	Type I
Mandible 6	Type III	Type II

that of the horizontal part ranged from 2.9-17.4mm. The vertical part coursed towards the MC, but instead of joining it directly continued backwards and joined the MC at the mandibular foramen (Fig. 4). The diameter of this RMC was 3mm. The type III canals (Fig. 5) also had a vertical part, that joined the MC, like the type I. From the anterior aspect of this vertical part, in each case a canal extended anteriorly, one for 20.3mm and another for only 3mm. The diameter of this RMC was more than that of the previous 2 types.

Table 2.- Morphometry (in mm) of the RMC in 6 mandibles.

Type	Mandible number	Vertical part		Horizontal part		Diameter	
		Right	Left	Right	Left	Right	Left
Type I	1	14.5	20.3	-	-	1.50	1.50
	2	11.6	18.3	-	-	1.50	1.50
	3	-	11.6	-	-	-	1.50
	5	-	14.5	-	-	-	1.50
Type II	3	8.7	-	17.4	-	3	-
	4	14.5	11.6	5.8	8.7	3	3
	6	-	8.7	-	2.9	-	3
Type III	5	17.4	-	2.9	-	3	-
	6	14.5	-	20.3	-	4.35	-

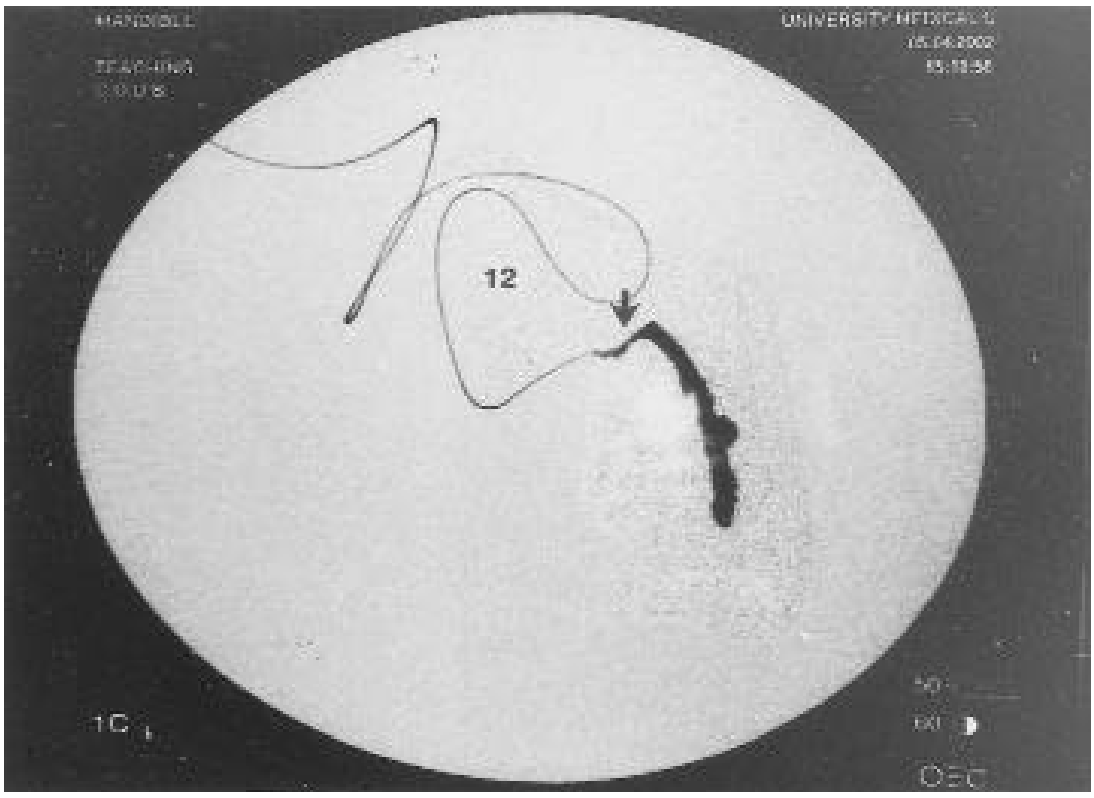

Figure 3.- X-ray photograph of a mandible showing the type I RMC (arrow). Note that the image of the mandible is subtracted.

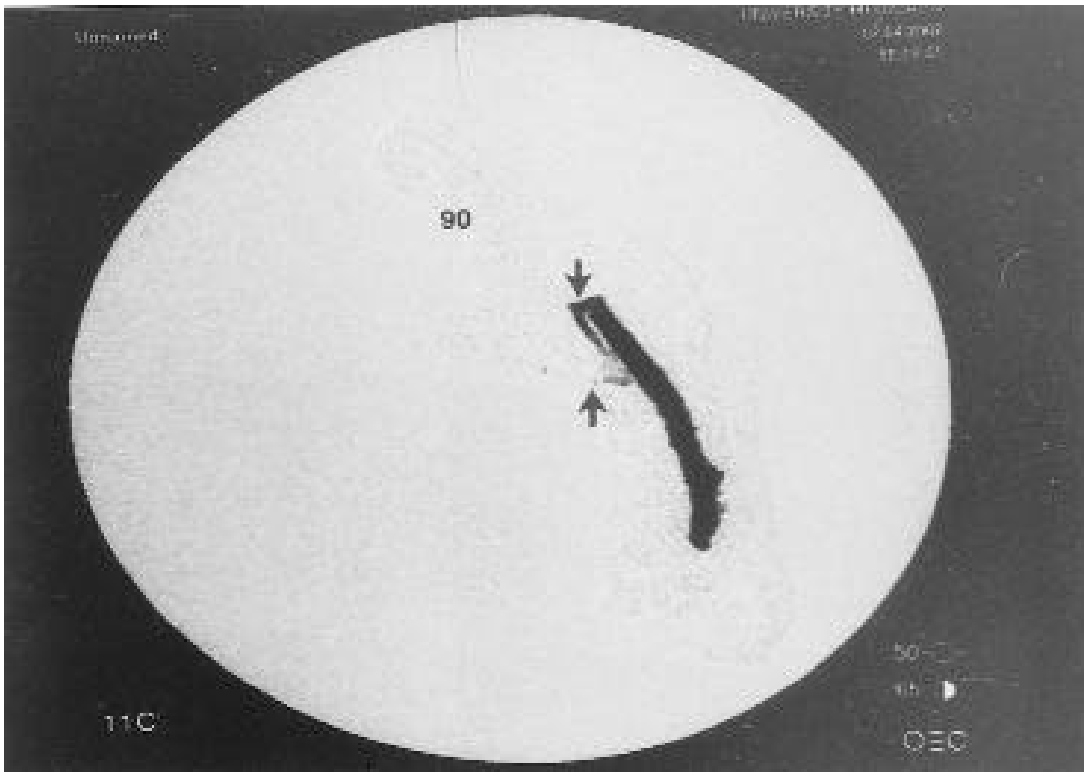

Figure 4.- X-ray photograph of a mandible showing the type II RMC. Note that the mandible and beginning of the RMC (arrow) are subtracted.

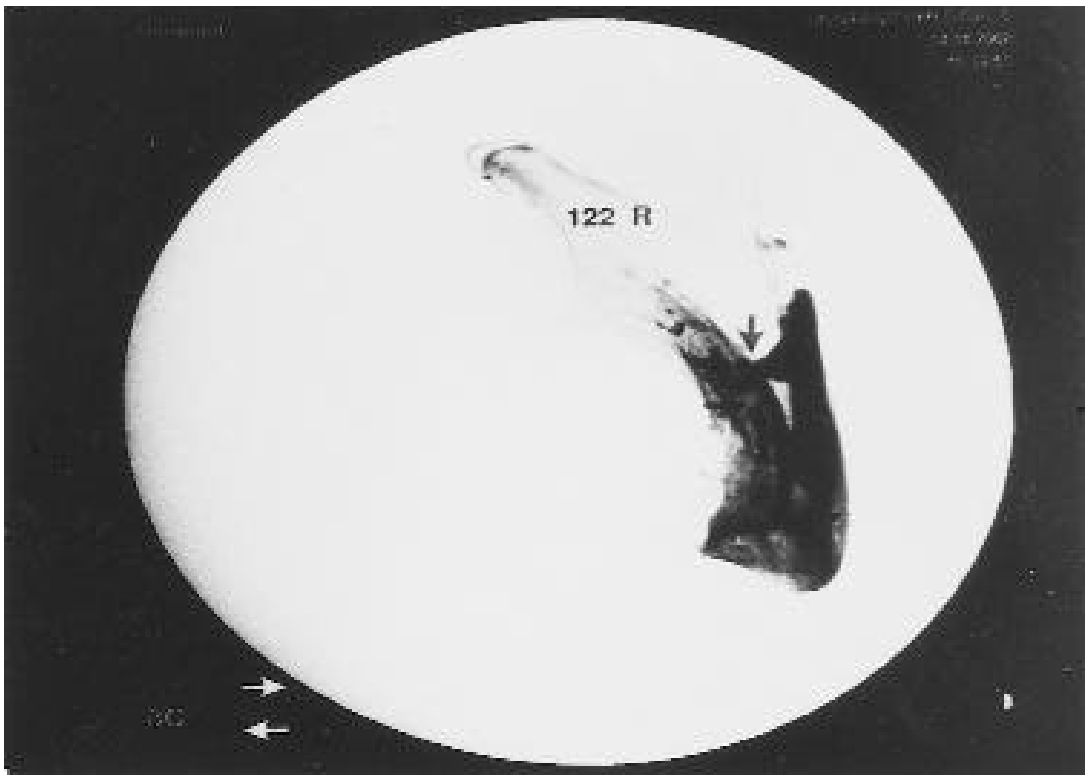

Figure 5.- X-ray photograph of a mandible showing the type III RMC. The horizontal part of the RMC is seen running anteriorly parallel to the MC. The image of the mandible is not subtracted.

DISCUSSION

This study was aimed to evaluate the incidence and morphology of the RMF and RMC. The incidence of RMF (21.9%) observed in this study is higher than the previously reported incidence of 7.7% (Sawyer and Kiely, 1991). However, when only the foramina of >0.5mm in diameter were considered (8.2%), the incidence was almost the same. This higher incidence is therefore due to the inclusion of all foramina in the triangle, irrespective of their diameter, in contrast with previous studies, which considered only those measuring >0.5mm in diameter (Ossenberg, 1987). The absence of side differences is in agreement with previous reports (Sawyer and Kiely, 1991) indicating the absence of unilateral dominance. The position of the RMF (Fig. 2) was not located in a constant position on either side, but when average distances were considered there were no side differences in its location. However, the distances ranged respectively from 3-17, 2-10 and 7-24mm on the right side and 5-12, 2-11 and 7-23mm on the left side. This indicates that if the foramen is suspected in a patient, it is not possible to locate it exactly using the reference of the above mentioned landmarks. Moreover, it also indicates that the position of the RMF is not constant, like that of the mandibular foramen (Mbajiorgu, 2000; Keros et al., 2001). In all cases, the foramen opened upwards and backwards, with a posterior smooth surface indicating the entry of the neurovascular bundle from the posterior aspect. The nerve that passes through this foramen, which is a branch of inferior alveolar (Kondera and Hasimoto, 1995), could escape the inferior alveolar nerve block.

The contrast radiographs of the RMC obtained in this study have enhanced our understanding of these abnormal canals. Previous studies have addressed only the MC using panoramic radiographs (Polland et al., 2001) or serial sections of mandibles (Obradovic et al., 1993), but not the RMC, except for one report by Kondera and Hashimoto (1995). This study showed that the RMC is a complicated abnormal canal, and presents different morphologies. However, even though further study is required and in a larger sample size, it is apparent that the type I canal is the most common and simplest one. It courses downwards approximately 12mm behind the third molar to join with the MC. However, all other types of canals also open into the MC. The type II canal opens into the MC at the mandibular foramen, suggesting that the neurovascular bundle of the RMC reaches the MC. The type III canal was relatively a rare occurrence and probably a more complicated pattern of the RMC since it traversed with a close relation to the teeth. Only one canal measured 20.3mm, which could be compared with the one previously reported by Kondera and Hashimoto (1995).

Another important aspect of these canals is that they vary considerably in their morphometry, especially in their length (Table 2), indicating that they could form the variable relation to the dental alveoli.

This study has therefore clearly established the types, course and morphometry of the RMC. It is possible to study this canal in living subjects by angiographic technique by introducing the dye into the inferior alveolar artery. This may provide more information about this canal. It remains unknown, how the RMC develops in the mandible, but it appears that the presence of an abnormal neurovascular bundle determines its formation. Irrespective of the type of the canal, its presence should be taken seriously, since it could inadvertently be compromised in surgical procedures to the mandible. Furthermore, the neurovascular bundle of the RMC could escape the inferior alveolar nerve block, as in the case of the nerves of numerous unnamed foramina in the mandible (Jayasheelan and Sharma, 1984). Moreover, if the RMC establishes contact with the cortical bone, then the risk of neurosensory disturbances would be increased, as seen with the contact of the MC and the cortical bone (Yamamoto et al., 2002).

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