

Original Article

Anatomical and radiographical study of the retromolar canal and retromolar foramen in macerated mandibles

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Abstract: Purpose: The aim of this study was to analyze the presence of the RMF in mandibles, considering gender and ethnic group. The RMC was also analyzed using periapical radiography. Methods: Eighty-six mandibles from adult individuals of both sexes, of white and black skin colours were analyzed. The presence of RMF (bilateral or unilateral) was observed, with the side and the number of foramina in each hemimandible. Five mandibles were selected for RMC evaluation by periapical radiography. Results: We observed at least 1 RMF in 16 mandibles out of a total of 86 (18.60%) and in 21 out of 172 sides (12.20%). The percentages were 27% in black individuals, 15.6% in white individuals, 23.8% in females and 13.8% in males. Conclusions: The RMF is a reasonably frequent anatomical variation and shows no differences between sexes or ethnic group, can be unilateral or bilateral and presents no side preference. The RMC presents different types of course and can even establish contact with the alveolar cortical, which might further complicate surgical and anaesthetic procedures in this region.

Keywords: Mandible, retromolar foramen, retromolar canal, periapical radiography

Introduction

The knowledge about the morphology of the mandible and its anatomical variations is very important for planning various dental clinical procedures. One or more foramina, known as retromolar foramina, may be found in the region of the retromolar triangle. The retromolar foramen (RMF) is the aperture of the retromolar canal (RMC), and its clinical importance rests on the presence of the neurovascular bundle, which passes through it.

Studies in cadavers report that the neurovascular bundles contain mainly thin nerve fascicles of myelinated nerve, arterioles and venules [1, 2]. Various surgical procedures may occur in the retromolar area, such as extraction of an impacted third molar [1] and sagittal split ramus osteotomy; damage to the vessels and nerves in this region could cause unexpected bleeding or paresthesia [3]. The retromolar canal and the retromolar foramen correspond to a frequent anatomical variation [3], which must be taken into account in surgical and anaesthetic procedures involving the retromolar region.

The aim of this study was to analyze the presence of RMF in macerated mandibles, considering gender and ethnic group and furthermore to analyze the RMC by periapical radiography.

Materials and methods

Eighty-six macerated mandibles from adult individuals, both sexes, white and black skin colours were analyzed. Sixty-five of them were males, aged between 22 and 75 years (average age 48.95), divided between 11 black males and 54 white males; 21 were females, aged between 21 and 89 years (average age 45.21), divided between 11 black females and 10 white females.

Mandibles in poor condition or without information on sex and skin colour were excluded from the study. The presence of RMF (bilateral or unilateral) was observed, with the side and the number of foramina in each hemimandible. For statistical analysis Fisher's exact test was used, considering statistically significant $P < 0.05$.

Five mandibles were selected for RMC evaluation by periapical radiography. A steel wire was



Figure 1. Mandible (superior view) showing double RMF (right side) (arrows) and single RMF (left side) (arrow).

introduced into the RMF and the radiography was then carried out to show the course of the RMC.

Results

We observed at least 1 RMF in 16 mandibles out of a total of 86 (18.60%) and in 21 out of 172 sides (12.20%). Four mandibles (4.65%) presented RMF on the left side only, seven (8.13%) on the right side only and five mandibles (5.88%) presented bilateral RMF. We also observed one case of double bilateral RMF and 1 double left RMF (**Figure 1**). The RMF was present in 27% of black individuals, 15.6% of white individuals, 23.8% of female and 13.8% of male (**Table 1**). We did not observe statistical differences between white and black individuals ($P = 0.33$) and between male and female ($P = 0.31$). The RMF was more frequent unilaterally than bilaterally, however there was no significant statistical difference ($P = 0.07$).

Analyzing the RMC by periapical radiography, we observed that the canals followed alternative routes: 1- starting from the RMF, the RMC follows an anteroinferior course terminating in the mandibular canal (**Figure 2A**); 2- starting from each RMF there is a RMC which follows an anteroinferior direction; proximal of the mandibular canal the retromolar canals join to form a single canal which terminates in the mandibular canal (**Figure 2B**); 3- starting from the RMF the RMC initially follows a vertical course which then turns horizontal, terminating in the alveolar cortical of the inferior 3rd molar (**Figure 2C**); 4- starting from the RMF the RMC initially follows a vertical course which then turns horizon-

tal, terminating in the base of the alveolus of the inferior 3rd molar (**Figure 2D**); 5- starting from the RMF the RMC follows a vertical course, terminating in the mandibular canal (**Figure 2E**).

Discussion

Previous studies in dry mandibles and by Cone beam computed tomography evaluation have revealed that the frequency of RMF ranges from 3.2% to 75.4% (**Table 2**), depending on the study design. In our study we found a prevalence of 18.6%, which is close to the value reported by Motta-Junior et al [11], Lizio et al [5] who did a study on Italians and also Kodera and Hashimoto [10] who worked with Japanese. Ossenberg [13] states that the percentage of RMF alters between different populations, however we observed that the literature reports great variation in the prevalence of RMF in a single ethnic group, e.g. Japanese, with 3.2% being the lowest value found and 75.4% the highest [7, 14]. In South-Americans the prevalence varies between 12.9% and 26.58% [6, 16, 18], in Indians between 12.2% and 21.9% [9, 12, 14], and in Europeans between 8.1% and 25.6% [5, 8, 13]. Based on the data reported in the literature, we believe that the prevalence of this anatomical variation is not related to population.

Pyle et al [15] studied dry skulls of Afro-Americans and Caucasians and reported that there were no statistical differences based on race, a finding similar to that found in our study.

In our study the RMF was more commonly found in females than in males, however there was no statistically significant difference, corroborating findings of the majority of authors who have found no gender preference [4, 7, 8, 13, 15, 17].

There was no side preference for RMF and RMC in our study, just as was reported by Bilecenoglu and Tuncer [1], Patil et al [7], Sawyer and Kiely [17], Suazo et al [18] and von Arx et al [8]; however the studies of Han and Hwang [4] and Narayana et al [12] both reported greater frequency on the right side, while Motta-Junior et al [11] and Priya et al [14] reported greater frequency on the left side.

Previous studies have shown that the presence of RMF and RMC is usually unilateral [1, 2, 4, 5, 8, 9, 11-14, 16, 18]. In our study, the RMF and

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Table 1. Frequency of RMF found in our study, according to sex and ethnic group

	Males n= 65	Females n= 21	Black Individuals n= 22	White Individuals n= 64
Right Side	5 (7.7%)	2 (9.5%)	2 (9%)	5 (7.8%)
Left Side	1 (1.5%)	3 (14.3%)	2 (9%)	2 (3.1%)
Bilateral	3* (4.6%)	2* (9.5%)	2* (9%)	3* (4.7%)
Total	9 (13.8%)	5 (23.8%)	6 (27%)	10 (15.6%)

Note: *number of mandibles.

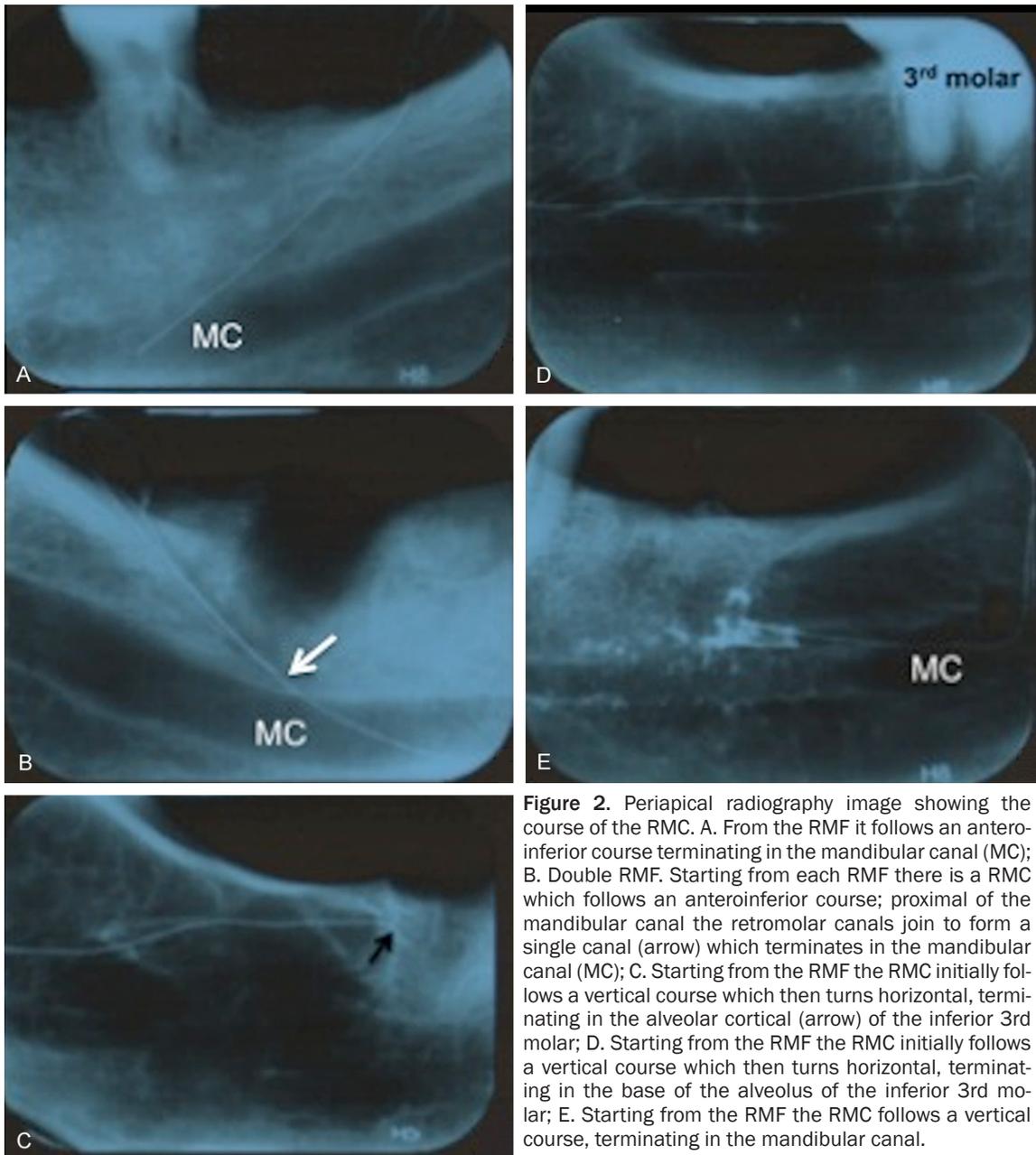


Figure 2. Periapical radiography image showing the course of the RMC. A. From the RMF it follows an antero-inferior course terminating in the mandibular canal (MC); B. Double RMF. Starting from each RMF there is a RMC which follows an antero-inferior course; proximal of the mandibular canal the retromolar canals join to form a single canal (arrow) which terminates in the mandibular canal (MC); C. Starting from the RMF the RMC initially follows a vertical course which then turns horizontal, terminating in the alveolar cortical (arrow) of the inferior 3rd molar; D. Starting from the RMF the RMC initially follows a vertical course which then turns horizontal, terminating in the base of the alveolus of the inferior 3rd molar; E. Starting from the RMF the RMC follows a vertical course, terminating in the mandibular canal.

RMC were more frequent unilaterally, however we found no statistically significant difference.

Turning to the morphology of the canal, in the majority of cases it presents a vertical course,

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Table 2. Frequency of RMF in various worldwide populations considering sex and side

Authors	n	Population	Frequency	Sex	Side		Unilateral
					Left	Right	
<i>Cone Beam Computed Tomography studies</i>							
Kawai et al [3]	46	Japanese	52%	-	-	-	-
Han and Hwang [4]	446	Korea	8.5%	*	23.7%	57.9%	81.6%
Lizio et al [5]	187	Italian	16%	-	-	-	91.3%
López-Videla et al [6]	84	South american	23.80%	-	-	-	-
Patil et al [7]	171	Japanese	75.4%	*	**		55.5%
von Arx et al [8]	100	Swiss	25.6%	*	**		81%
<i>Human mandibles studies</i>							
Schjtman et al [2]	18	Argentine aborigines	72%	-	-	-	73%
Kodera and Hashimoto [10]	41	Japanese	19.5%	-	-	-	-
Motta-Junior et al [11]	35	-	17.1%	-	50%	16.7%	66.7%
Narayana et al [12]	242	Indian	21.9%	-	32.1%	49%	81.1%
Ossenberg [13]	86	Italian	8.1%	*	-		-
	94	Japanese	3.2%				
	485	Eskimos	40%				
	11	Canadians	9.1%				
Priya et al [14]	157	Indian	12.7%	-	39.3%	32.1%	71.4%
Pyle et al [15]	249	African	7.8%	*	-	-	-
		American					
	226	Caucasian					
Rossi et al [16]	222	Brazilian	26.58%	-	-	-	69.5%
Sawyer and Kiely [17]	234	American	7.7%	*	**		-
Suazo et al [18]	294	Brazilian	12.9%	-	**		71.1%
<i>Third molar surgery studies</i>							
Bilecenoglu and Tuncer [1]	40	Turkish	25%	-	**		80%

Note: -no related; *no gender predilection; **no side predilection.

i.e. a vertical canal joining the mandibular canal to the RMF [8]. Kawai et al [3] suggest that the RMC generally runs upward to the lingual portion of the mandibular canal. The important aspect of the RMC is the fact that it contains the nerve responsible for innervating the most posterior region of the alveolar process, including the mandibular molars [8].

Some authors suggest that the presence of an abnormal neurovascular bundle might determine the formation of the RMC [12], however it is still not clear how the RMC develops in the mandible. In our study we observed that the RMC presents different types of course, which might further complicate surgical and anaesthetic procedures in this region. We observed that the RMC can establish contact with the alveolar cortical, which according to Yamamoto et al [19] could increase the risk of neurosensory alterations.

In summary, our results allow us to state that the RMF shows no differences between sexes or ethnic groups, can be unilateral or bilateral and presents no side preference. Our results also showed that the RMF is a reasonably frequent anatomical variation. Furthermore, we can conclude that the RMC presents different types of course and can even establish contact with the alveolar cortical, which might further complicate surgical and anaesthetic procedures in this region.

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Disclosure of conflict of interest

None.

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