Radiographic Study of the Mandibular Retromolar Canal: An Anatomic Structure with Clinical Importance

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Abstract

Introduction: The retromolar canal is an anatomic structure of the mandible with clinical importance. This canal branches off from the mandibular canal behind the third molar and travels to the retromolar foramen in the retromolar fossa. The retromolar canal might conduct accessory innervation to the mandibular molars or contain an aberrant buccal nerve. **Methods:** Patients referred for panoramic radiography were consecutively enrolled, provided a limited cone-beam computed tomography (CBCT) scan had also been taken in the area of interest. Radiographs were retrospectively screened for the presence of a retromolar canal, and linear measurements (distance to second molar, height, width) were taken. **Results:** One hundred twenty-one sides in 100 patients were evaluated (100 unilateral and 21 bilateral cases). A total of 31 retromolar canals were identified with CBCT (25.6%). Only 7 of these canals were also seen on the corresponding panoramic radiographs. The existence of a retromolar canal was not statistically related to gender or side. With regard to the linear measurements, the mean distance from the retromolar canal to the second molar was 15.16 mm ($\pm$2.39 mm), the mean height of the canal was 11.34 mm ($\pm$2.36 mm), and the mean width was 0.99 mm ($\pm$0.31 mm). **Conclusions:** This radiographic study documents a frequency of 25% for the presence of a retromolar canal. The clinician is advised to preserve this anatomic variation when performing surgery in the retromolar area and to consider additional locoregional anesthesia in the case of failed mandibular block anesthesia. *(J Endod 2011;37:1630–1635)*

Key Words

Accessory innervation, mandibular anatomy, retromolar canal, retromolar foramen

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The retromolar canal in the mandible is an anatomic structure that has rarely been studied in the dental literature and has generally been neglected in anatomic textbooks. The retromolar canal normally arises from the mandibular canal behind the third molar and travels anterosuperiorly to the retromolar foramen, which is located in the retromolar fossa. Bilecenoglu and Tuncer (1) reported mean distances of 4.2 mm and 11.9 mm from the retromolar foramen to the distal aspect of the alveolar socket of the third and second molars, respectively. The few cadaver studies that have evaluated the existence of the retromolar foramen have reported great variability, with a frequency of up to 72% depending on the study design, ie, the minimum size required for an opening in the bony surface to be defined as a foramen (2–5).

The content of the retromolar canal has been evaluated in cadavers (2, 6) and in clinical biopsy reports (1, 7). The neurovascular bundle was found to contain predominantly thin nerve fascicles of myelinated nerve fibers, numerous venules, and small arteries accompanying the nerve fibers.

The clinical significance of the existence of a retromolar canal and of its neurovascular content is not yet clear. Some authors have demonstrated that a neural branch to the mandibular molars arises from the inferior alveolar nerve or from the retromolar branch that travels through the retromolar canal (8, 9). Others have shown an aberrant buccal nerve originating from the inferior alveolar nerve within the ramus of the mandible, traversing through the retromolar canal, emerging through the retromolar foramen, and then passing forward and upward to penetrate the buccinator muscle (3). Such a variation in the course of the buccal nerve was also mentioned in another publication (7). That case report described unilateral paresthesia of the buccal sulcus subsequent to trauma to a slender nerve emerging from the retromolar foramen. Schejtman et al (2) assessed the course of the neurovascular bundle originating from the retromolar foramen in 18 human cadaver heads. After leaving the foramen, these elements were distributed mostly to the temporal tendon, the buccinator muscle, the most posterior zone of the alveolar process, and the third mandibular molar. Accessory innervation, with branches of the mandibular division entering the mandible in the retromolar fossa and carrying sensory fibers to the mandibular molars, has also been described (10).

The objectives of the present study were (1) to evaluate how frequently the retromolar canal is visible on radiographs by using panoramic radiography and limited cone-beam computed tomography (CBCT) and (2) to take linear measurements of the retromolar canal.

Materials and Methods

Patients who had been referred for panoramic radiography were consecutively enrolled in the study, provided a CBCT scan had been taken that showed the retromolar area of the mandible. Because of the retrospective nature of the present analysis, the study was exempt from formal approval by the ethical committee of the State of Bern.

The main reasons for referral were retained or impacted third molars. Patients were enrolled from January 2009–December 2010 and were fully informed about the radiographic diagnostics. There was an equal number of men and women (50 cases each), with a mean age of 36.1 years (range, 16–83 years). A total of 121 sides were evaluated in 100 patients (39 right sides, 40 left sides, and 21 bilateral cases).

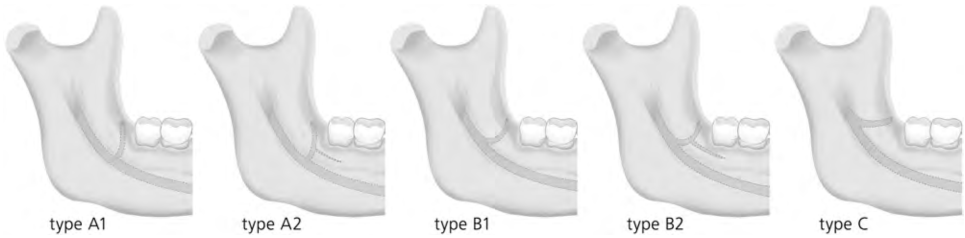

Figure 1. Schematic illustrations of different configurations of the retromolar canal.

According to the as low as reasonably achievable principle of radiation exposure, CBCT was only performed for additional 3-dimensional topographical information that was considered necessary for further diagnosis or for the surgical removal of the mandibular third molars, and CBCT scans were performed by using a limited field of view (FOV).

The panoramic radiographs were made with a Cranex D (Soredex, Tuusula, Finland) with exposure settings of 10 mA and 73 kV. The scanning time was 15 seconds. CBCT scans (3D Accuitomo XYZ Slice View Tomograph; Morita, Kyoto, Japan) were taken with a basic voxel size of 0.08 mm and exposure settings of 5.0–7.0 mA and 80 kV. The scanning time was 17.5 seconds. Cylindrical volumes (fields of view/FOV) measured 40 × 40 mm or 60 × 60 mm. CBCT images were viewed on a computer screen and reformatted into multiplanar reconstructions to obtain the most appropriate sections for assessment and taking measurements. The panoramic radiographs and the sagittal CBCT images were screened for the presence and type of mandibular retromolar canal. The retromolar canals were further classified into 5 categories according to the course and morphology (Fig. 1): vertical course of retromolar canal (type A1), vertical course of retromolar canal with additional horizontal branch (type A2), curved course of retromolar canal (type B1), curved course of retromolar canal with additional horizontal branch (type B2), and horizontal course of retromolar canal (type C).

In addition, the following linear measurements were taken by using sagittal CBCT images (Fig. 2): the horizontal distance from the midpoint of the retromolar foramen to the distal cementoenamel junction (CEJ) of the second molar, the vertical distance (height) from the midpoint of the retromolar foramen to the upper border of the mandibular canal, and the width of the retromolar canal at a level of 3 mm below the mesial aspect of the retromolar foramen.

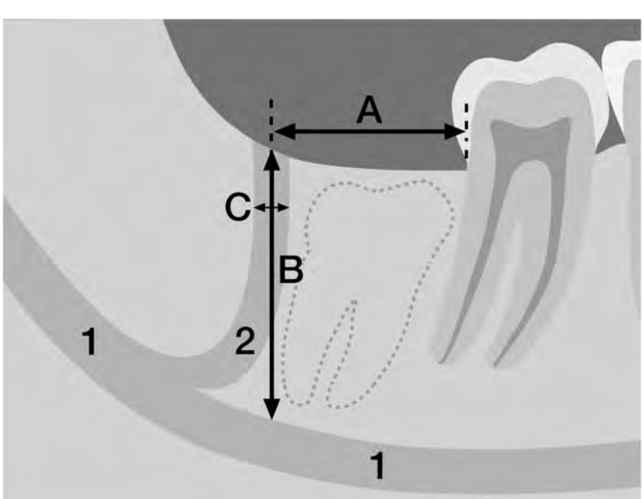

Figure 2. Schematic illustration of linear measurements taken of the retromolar canal: (1) mandibular canal, (2) retromolar canal, (A) horizontal distance from retromolar canal to second molar, (B) height of retromolar canal, (C) width of retromolar canal.

The panoramic radiographs were only analyzed on the side (left, right, or both sides) for which a CBCT scan had also been performed according to the indication of patient referral. To study the precision of the linear measurements taken with CBCT, the horizontal distances from the retromolar canal to the second molar were measured as described above, and measurements were repeated 1 week later, showing a high correlation (Spearman correlation coefficient, 0.998). The first measurements were used for further analysis.

Statistics

Data were first analyzed by using descriptive statistics. Summary measures were complemented with 95% confidence intervals. In addition, inferential statistical methods were used. The test of proportions was applied to compare differences in detected retromolar canals by using CBCT or panoramic radiography on the right and left sides, respectively. A multivariate linear regression model was used to assess the joint impact of age, gender, and canal type on the horizontal distance from the midpoint of the retromolar foramen to the distal aspect of the second molar, the height and the width of the retromolar canal, respectively. All statistical analyses were performed by using Stata software (Stata version 11.2; StataCorp, College Station, TX).

Results

A total of 31 retromolar canals were detected with CBCT images in 121 sides (25.6%) (Table 1). Only 7 of these 31 retromolar canals were identified with the corresponding panoramic radiographs (Table 1). More women than men and more left sides than right sides tended to have retromolar canals, but these differences did not reach statistical significance (P = .205 and P = .409, respectively) (Table 2). Of the 21 cases with bilateral evaluation, only 4 (19%) presented with a retromolar canal on both sides (Table 3).

With regard to canal morphology, most retromolar canals had a vertical course (type A1, 41.9%) or were slightly curved (type B1, 29.0%). Type C, ie, a horizontal course, was never identified (Table 4).

The linear measurements are summarized in Table 5. The mean distance from the midpoint of the retromolar foramen to the distal aspect of the second molar (CEJ) was 15.16 mm (±2.39 mm; range, 12.32–22.32 mm). The linear regression analysis identified age as a statistically significant factor (P = .062), with younger patients having a longer distance (a 10-year increase in age was associated with a reduction of that distance by 0.89 mm).

The mean height of the canal (vertical distance from retromolar foramen to mandibular canal) was 11.34 mm (±2.36 mm; range, 7.43–18.17 mm). Linear regression analysis demonstrated gender as a significant factor (P = .025), with men having higher values than women (mean difference, 2.06 mm). The mean diameter of the

TABLE 1. Radiographic Findings per Sites (n = 121)

	Right side		Left side		
	Male	Female	Male	Female	Total
Total of CBCTs	26	34	31	30	121
CBCTs with a retromolar canal	6	8	7	10	31
Percentage of CBCTs showing a retromolar canal	23.1	23.5	22.6	33.3	25.6
Panoramic radiographs showing a retromolar canal	2	2	1	2	7

retromolar canal measured at 3 mm below the retromolar foramen was 0.99 mm (±0.31 mm; range, 0.5–1.75 mm). No significant differences were found for age (P = .520) and gender (P = .446).

Discussion

The present radiographic study evaluated the presence and morphology of the retromolar canal in 100 patients by means of panoramic radiography and limited CBCT (Figs. 3–5). Previous studies on the incidence of the retromolar canal have been conducted by using cadaver mandibles, and those studies generally assessed the retromolar foramen rather than the retromolar canal. Because of differences in methodology, cadaver studies have reported a wide range of incidences of the mandibular retromolar foramen (0–72%), whereas the present study found a frequency of 25.6% for the retromolar canal. In fact, cadaver studies including only retromolar foramina with a minimum size of 0.5 mm have reported that the frequency of the retromolar foramen never surpassed 25% (1, 11–13).

As the present study has shown, the ability to detect a retromolar canal with panoramic radiography is limited. Of 31 canals seen with CBCT, only 7 were visible on corresponding panoramic radiographs. One explanation might be that the retromolar canal is too thin to be detected (mean width, 0.99 mm; range, 0.5–1.75 mm). To our knowledge, the present study is the first to compare panoramic radiography with CBCT for radiographic analysis of the retromolar canal in patients. In a case report, Kaufmann et al (14) presented a bilateral retromolar canal that was seen with CT but that was not visible with panoramic radiography.

With regard to side or gender predilection, the present study failed to demonstrate any significant differences. Of 100 enrolled cases, only 21 cases included panoramic radiographs with bilateral CBCTs of the retromolar areas. Interestingly, only 4 of these 21 cases had bilateral retromolar canals, with another 5 cases having a unilateral canal. Priya and Manjunath (13) assessed 157 south Indian mandibles and reported bilateral retromolar foramina in 5.1% and a unilateral foramen in 12.7%. Bilecenoglu and Tuncer (1) evaluated 40 mandibles and found a bilateral retromolar foramen in 5% and a unilateral foramen in 20%. Narayana et al (5) studied 242 dry adult mandibles of south Indian origin. The authors reported a bilateral occurrence of the retromolar foramen in 4.1% and a unilateral occurrence in 17.8%, with no difference between left and right sides.

Ossenberg (11) collected data from museum archaeological collections and reported that the retromolar foramen occurred unilaterally more often than bilaterally, with generally a higher ratio of bilateral to unilateral occurrence in populations with a high frequency of the retromolar foramen.

With regard to gender, women tended to have a retromolar canal more often than men in the present study, but no statistical difference was found. Ossenberg (11) reported a slightly greater incidence of the retromolar foramen in males, but without reaching statistical significance. Also Pyle et al (4) found a higher occurrence rate of the retromolar foramen in male skulls (9.6%) than in female skulls (6.1%).

Concerning occurrence of the retromolar foramen and age, Pyle et al (4) noticed no statistically significant difference between age groups in a sample of 475 dry cadaver skulls. In contrast, Ossenberg (11) reported a peak incidence of the retromolar foramen in the adolescent cohort. The author speculated that this might reflect increased neurovascular requirements related to the adolescent growth spurt and eruption of the wisdom teeth.

Regarding measurements of the retromolar canal, Bilecenoglu and Tuncer (1) reported a mean distance of 11.9 mm (range, 9.5–24.3 mm) from the retromolar foramen to the second molar. This value is about 3 mm shorter than the mean calculated distance in the present study. The difference might be explained by the following facts: (1) the present study evaluated radiographs, whereas Bilecenoglu and Tuncer assessed cadaver heads; (2) in the present study the distance was measured from the midpoint of the retromolar foramen, whereas Bilecenoglu and Tuncer measured from the mesial aspect of the retromolar foramen; and (3) only 4 cadaver heads presented with a second molar in the material of Bilecenoglu and Tuncer.

In the present study, age was found to be a significant factor for the horizontal distance between the retromolar foramen and the second molar, with younger patients having a longer distance. We can only speculate that the third molar still present in younger patients maintains a larger distance between the retromolar canal and the second molar, whereas in older patients whose third molars have been removed, the second molar might move slightly or tip distally, reducing the

TABLE 2. Frequency of Detected Retromolar Canals (n = 121)

Study parameters	Subgroups	n/n^{total}	Percentage
Radiograph	CBCT	31/121	25.6
	Panoramic radiography	7/121	5.8
Gender	Male	13/57	22.8
	Female	18/64	28.1
Age	<20 y	3/12	25.0
	20–40 y	23/77	29.9
	>40 y	5/32	15.6
Side	Right	14/60	23.3
	Left	17/61	27.9

TABLE 3. Summary of Cases with Bilateral Analysis (n = 21)

	n	Percentage
No retromolar canal	12	57.1
Canal only on right side	4	19.0
Canal only on left side	1	4.8
Canal on both sides	4	19.0
Total	21	100

TABLE 4. Distribution of Retromolar Canals According to Type (n = 31)

	n	Percentage
Type A1	13	41.9
Type A2	5	16.1
Type B1	9	29.0
Type B2	4	12.9
Type C	—	—
Total	31	100

TABLE 5. Linear Measurements of the Retromolar Canals (n = 31)

	Mean ± SD	Range	95% CI
Horizontal distance from midpoint of retromolar foramen to second molar	15.16 ± 2.39 mm	12.32–22.32 mm	14.28–16.03 mm
Height of retromolar canal	11.34 ± 2.36 mm	7.43–18.17 mm	10.47–12.21 mm
Width of retromolar canal	0.99 ± 0.31 mm	0.5–1.75 mm	0.87–1.10 mm

horizontally measured distance. In the present study, all but 1 of the 31 sides showing a retromolar canal in the CBCT scans had a third molar. Therefore, we could not show whether the presence or the absence of a third molar really influences the horizontal distance from the retromolar canal to the second molar.

With regard to the height and width of the retromolar canal, such information has rarely been collected in other studies, and thus direct comparisons between our study and others is difficult. Other studies have mainly assessed the retromolar foramen and not the retromolar canal. The mean width of the canal in the present study was 0.99 mm. Priya and Manjunath (13) reported a mean size of 2 mm for the retromolar foramen (cadaver study), whereas Narayana et al (5) reported widths ranging from 1.5–4.35 mm for the retromolar canal, but without specifying the level of measurement. In the latter study, the authors reported lengths of the retromolar canal ranging from 8.7–20.3 mm. These data are in accordance with the measurements of the present study (7.43–18.17 mm). Gender was found to be a significant factor, with men having longer retromolar canals than women in the present study. This difference is not necessarily explained by the fact that men have an overall greater height of the mandible in the retromolar area, because the length of the canal was determined as the distance from the mandibular canal to the retromolar foramen. Hence, the length of the retromolar canal is dependent on the location of the mandibular canal within the mandible.

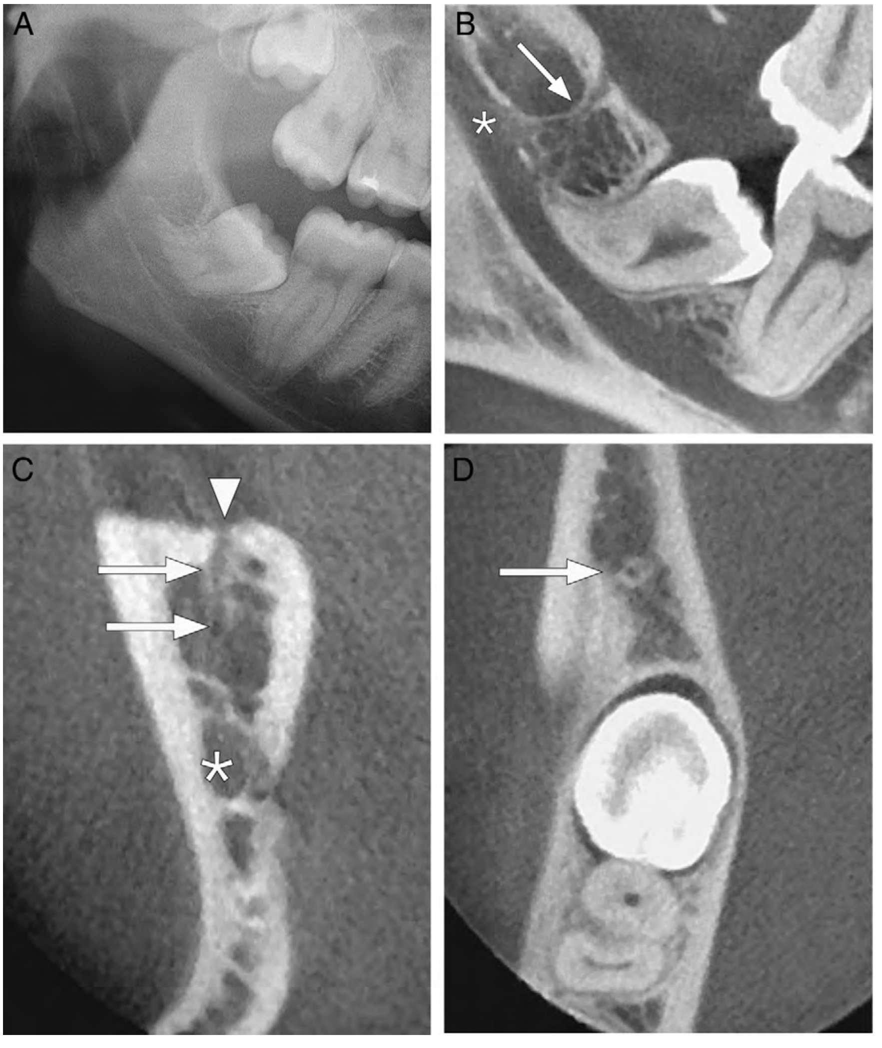

Figure 3. (*A*) Detail of panoramic radiograph of right mandibular retromolar area; retromolar canal is not visible (25-year-old woman). (*B*) Sagittal CBCT cut shows a curved retromolar canal (*arrow*) behind the right mandibular third molar branching from the mandibular canal (*asterisk*). (*C*) Retromolar canal (*arrow*) is also visible in the coronal CBCT cut with its opening, the retromolar foramen (*arrowhead*) (*asterisk* indicates the mandibular canal). (*D*) Axial CBCT cut shows the retromolar canal (*arrow*) with its cortical bone lining.

Figure 4. (*A*) Detail of panoramic radiograph of left mandibular retromolar area; retromolar canal is visible (*arrow*) (25-year-old woman, same case as in Figure 3). (*B*) Sagittal CBCT cut shows a curved retromolar canal (*arrow*) behind the left mandibular third molar branching from the mandibular canal (*asterisk*). (*C*) Retromolar canal (*arrow*) is also visible in the coronal CBCT cut with its opening, the retromolar foramen (*arrowhead*) (*asterisk* indicates the mandibular canal). (*D*) Axial CBCT cut shows the retromolar canal (*arrow*) with its cortical bone lining.

Scarce but consistent information is available regarding the content of the retromolar canal. The neurovascular bundle consists mainly of small arteries, numerous venules, and myelinated nerve fibers (1, 2, 6, 7). Uncertainty remains as to whether these structures are entering or exiting the bone. A possible indication for the direction of the anatomic structures inside the retromolar canal might be changes in the diameter of this accessory canal from the point of larger to the point of smaller diameter (14).

Several authors have highlighted the importance of the retromolar foramen and canal with accessory innervation, but also with failure of locoregional anesthesia in dentistry (15). Branches of the mandibular division of the inferior alveolar nerve can arise high in the infratemporal fossa and extend to the base of the coronoid process to enter the mandible in the retromolar fossa and to allow sensory fibers to innervate the mandibular molars (10). On the other hand, the buccal nerve might have an aberrant course, originating from the inferior alveolar nerve within the ramus, running through the retromolar canal, and exiting through the retromolar foramen (3, 7). This might put a patient at risk for surgical nerve damage during third molar surgery in the mandible.

Sawyer and Kiely (12) reported significant positive correlation of an accessory mandibular foramen with a retromolar foramen regarding same-side occurrence. That means that when an accessory mandibular foramen is present, there is a high likelihood that there will be a horizontal bony canal leading to a foramen in the retromolar fossa or below the coronoid process. This bony canal could be the so-called temporal crest canal that was first described by Ossenberg (16).

Conclusions

The present study demonstrated the presence of a retromolar canal in 25.6% of CBCTs and in 5.8% of panoramic radiographs. Age, gender, and side did not statistically affect the presence of the retromolar canal. Current knowledge of the retromolar canal is mainly based on cadaver studies and few case reports, most of them addressing the retromolar foramen rather than the canal. Histologic studies about the content of the mandibular canal consistently report the presence of myelinated nerves, small arteries, and abundant venules. 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 anesthetic failure (mandibular

Figure 5. (*A*) Detail of panoramic radiograph of left mandibular retromolar area; retromolar canal is not visible (46-year-old man). (*B*) Sagittal CBCT cut shows a vertical retromolar canal (*arrow*) behind the left mandibular third molar (*asterisk* indicates the mandibular canal). (*C*) The relatively long retromolar canal (*arrow*) is also visible in the coronal CBCT cut (*asterisk* indicates the mandibular canal). (*D*) Axial CBCT cut shows the retromolar canal (*arrow*). Further distal, the mandibular foramen (*arrowhead*) and the mandibular canal (*asterisk*) are visible.

block), the clinician is advised to consider the neural elements of the retromolar canal as a possible cause.

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The authors deny any conflicts of interest related to this study.

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