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Radiographic evaluation of the visibility of the mandibular canal of a Senegalese population

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Abstract
The visibility of the mandibular canal varies according to individuals and its path in the same individual. The purpose of this study was to assess the visibility of the mandibular canal path on digital panoramic X-rays.
Materials and methods: This is a cross-sectional study of panoramic radiographs of Senegalese subjects. The path of the mandibular canal was subdivided into three areas: posterior, middle, and anterior.
Results: Of the 215 digital panoramas analysed, the mandibular canal (CM) was invisible in the anterior area in 96% (n=413). In the middle portion of the mandible, in 65.3% (n=281) of cases the CM was less visible 62.3% (n=134). It was more visible in the posterior area.
Conclusion: The mandibular canal was more easily identified in the posterior areas, and visibility gradually diminished towards the mental foramen.

Keywords: panoramic X-ray, anatomy, mandibular canal

1. Introduction
The mandibular canal is an important anatomical landmark that must be considered before any surgery on the posterior region of the mandible [1, 2, 3]. Preoperative radiological diagnosis can provide information on anatomical relationships between the canal and dental and bone structures, thus preventing vascular nerve damage [4]. Studies on the topography of the mandibular canal have shown anatomical variations in its path [5, 6]. In addition, the radiographic aspect of the mandibular canal may vary. In panoramic radiography images, the mandibular canal is generally seen as a well-defined radioclear area, bordered by radiopaque upper and lower boundaries [4]. Visibility of the mandibular canal varies according to individuals and its path in the same individual [7, 8]. Understanding the anatomical path variability and visibility of the mandible canal will be useful in planning treatment of procedures involving the posterior region of the mandible. The purpose of this study was to assess the visibility of the mandibular canal path on digital panoramic X-rays.

2. Materials and methods
This was a descriptive cross-sectional study. It included a sample of panoramic x-rays of patients referred to the modern imaging centre in Senegal (IMODSEN). Panoramic radiographs were prescribed by dentists working in Dakar. The survey was conducted from January to July 2017. The photographs were taken on a Soredex Cranex-DTM panoramic X-ray camera and the images were read on a computer screen with the manufacturer's viewer. Patient consent was obtained to use their panoramic images for this study. In these radiographic images, visibility of the path of the mandibular canal was investigated.

Selection criteria
Panoramic x-rays with radiopaque images, radioclear lesions in the peri-apixel of the mandibular molars, mandibular fractures, the absence of three molars, as well as technical errors and poor radiographic quality were excluded. Patients were not expected to have systemic pathologies that could alter bone architecture and degenerate the bone structure of the mandible. The X-rays were read by an observer, the dental surgeon specialized in radiology.

Procedure for collecting variables
The age and sex of the patients were first identified. The visibility of the lower and upper edges of the mandibular canal in 3 areas was the major feature studied. Using the viewer, a vertical line running distal from the first molar and one along the anterior margin of the mandibular ramus were drawn. Thus, the mandibular canal was divided into posterior, middle and molar areas (figure 1a, 1b).
The channel visibility was assessed as follows according to the classification of Nortje *et al* [7]:
Type 1: visible, if both the upper and lower radiopaque cortex were identified in the panoramic radiography;
Type 2: less visible, if only the lower cortex is visible;
Type 3: invisible, if the two cortex were not identifiable.

Statistical analysis
The data were collected and processed on the SPSS 20.0

software. The results were expressed as a percentage and actual. The Kruskal-Wallis test was used to examine the difference in visibility between the right and left sides. The p-value was less than 0.5 ($p<0.5$).

3. Results & Discussion

Results

A total of 215 digital panoramic radiographs of Senegalese subjects were selected to assess the topography of the lower dental canal. The results show a predominance of the female sex with 53.5% (n=115) and men accounted for 46.5% (n=100) of the sample. The average age was 35 ±21 with a minimum of 16 and à maximum of 80.

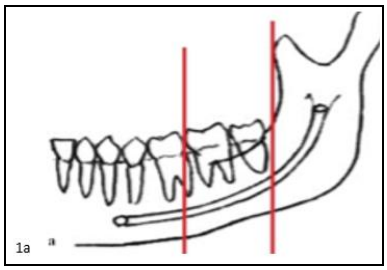
Of the 215 digital panoramas analysed, more than 200 showed that the lower dental canal was invisible in the anterior area of the mandible on the left and right, i. e. 96% (n=413) on average. However, CM was less visible en 3.9% (n=14) of cases on average (Table 1). In the middle portion of the mandible, en 65.3% (n=281) of cases the mandibular canal (CM) was less visible to the left 62.3% (n=134) and to the right 68.4% (n=147) and in more than 25.3% (n=109) of cases it was invisible. However, in more than 9.3% (n=40) of the cases, the DTA was visible (Table 2). In the posterior sector, in 25.6% (n=110) of cases the inferior dental canal was visible on the left and right and in 66% (n=284) of cases it was less visible (Table 2). No significant differences were found in the visibility of the CM between the right and left sides of the CM (Table 1, 2, 3). Visibility was not correlated in this study by sex and age (p=0.5, p=0.1).

Discussion

Visibility of the mandibular canal path was studied in this study on panoramic X-rays. The results showed the variation in channel visualization throughout the normal anatomical path. Panoramic radiography remains the most widely used complementary examination in anatomical exploration of the mandible, dental surgery wisdom, implantology in tumour and infectious pathologies. It provides a global vision of the anatomical structures of the facial mass on a spread out plane. The topographic survey of the lower dental canal in the panoramic radiography shows a clear radioclear line bordered by two radiopaque lines on either side of the canal. It originates at the mandibular vertical branch and follows in apical position the alignment of the teeth of the arch and finishes its course in the premolar region through the chin foramen. The results of this study showed that the posterior 1/3 portion was more visible with the reading of the two lower and upper cortical ducts of the canal in 25.6% (n=110), followed by the intermediate portion of 9.3% (n=40). Compared to the literature, these results confirm the variability in the visibility of the lower dental canal as a function of individuals and portions studied in panoramic radiography. Nemati *et al* [9] on 249 toothed Iranian subjects, the lowest visibility was localized at the anterior portion and the two canal corticals were sharper in the posterior 1/3, with no correlation with age and sex. In this study, the mandibular canal was invisible in 96.6% of the sites examined in the first molar region on panoramic radiographs.

Low visibility of the mandibular canal wall on a panoramic x-ray may indicate reduced bone trabeculation [10] or at the limits of panoramic x-ray, such as artefacts related to superimposed anatomical structures of different densities. Volume tomography with conical or cone beam CT (CBCT) or CT scans are sectional techniques that allow for clearer anatomical exploration. Jung *et al* [8] showed that the mandibular canal had generally satisfactory visibility on CBCT cross-sectional images in most cases. The mandibular canal was clearly visible in 50.4% of the examined sites in the first molar region on CBCT images and was probably visible in 41.4%. De Oliveira-Santos *et al* [11] reported that in CBCT cross-sectional images of the anterior portion, corticalization of the mandibular canal was observed in 59% of the hemi-mandibules and in 23% of cases, the canal was not corticalized but could be visualized. Radiographic diagnosis of a disease requires precise knowledge of anatomical markers and natural structures. Sometimes borders are seen only partially or not *et al* [12]. In maxillofacial surgeries, the mandibular canal is considered a reference anatomical structure. Extraction of the third mandibular molar, implant surgery, orthognatic surgery and treatment of mandibular fractures are high-risk cases of damage to the mandibular canal and lower alveolar nerve [13]. The proximity of molar roots to the mandibular canal can cause an injury to the lower alveolar nerve when these teeth are extracted [9]. Excessive instrumentation or overfilling in the mandibular premolars or molars during endodontic treatment can cause nerve damage. Orthodontic movements of the posterior mandibular teeth can put pressure on the lower alveolar canal and even paresthesia [14]. Poor assessment of the dental canal on panoramic x-rays can lead to post-traumatic trigeminal neuropathic pain after surgery, implant placement, invoice processing or endodontic mandible treatment.

4. Tables and Figures



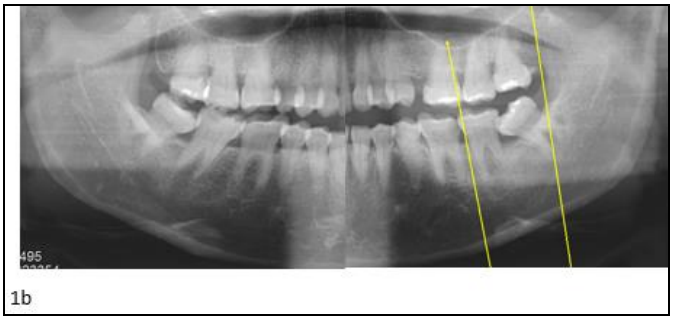


Fig 1: 1a: Diagram of a mandible dividing the mandibular canal by vertical lines with 3 sections (posterior, middle and anterior) 1b: view of the mandibular canal on panoramic x-ray.

Table 1: Visibility of the mandibular canal in the anterior portion of the mandible

	right		left		p-value	Total	
	n	%	n	%		n	%
Type 3	204	94,9	209	97,2	0,3	413	96,04
Type 2	11	5,1	6	2,8	0,2	17	3,96
Type 1	00	00	00	00		00	00
Total	215	100	215	100		430	100

Table 2: Visibility of the mandibular canal in the middle portion of the mandible

	right		left		p-value	Total	
	n	%	n	%		n	%
Type 3	47	21,9	62	28,8	0,3	109	25,35
Type 2	147	68,4	134	62,3	0,2	281	65,35
Type 1	21	9,8	19	8,8	0,3	40	9,30
Total	215	100	215	100		430	100

Table 3: Visibility of the mandibular canal in the posterior portion of the mandible

	right		left		p-value	Total	
	n	%	%	n		n	%
Type 3	18	8,4	18	8,4	0,1	36	8,4
Type 2	138	64,2	146	67,9	0,2	284	66,
Type 1	59	27,4	51	23,7	0,2	110	25,6
Total	215	100	215	100		430	100

5. Conclusions

The mandibular canal was more easily identified in the posterior areas, and visibility gradually diminished towards the mental foramen. The results of this study showed that the visibility of the mandibular canal in the third molar region was better than in the first molar region.

6. References

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