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**ORIGINAL ARTICLE**

# Appearance of anatomical structures of mandible on panoramic radiographs in Iranian population

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**Abstract**

***Purpose.*** Currently panoramic radiography is used for diagnosis of dental and bone lesions, but anatomical structures also can be seen and may be useful in dental managements. This study aimed to investigate the visibility of some important mandibular features relating to neurovascular structures in Iranian population. ***Materials and methods.*** Panoramic radiographs were taken by Planmeca machine from 412 patients using standard exposure. The position of patient was in compliance with standard protocol. Then mandibular incisive canal was evaluated and data were analyzed statistically. ***Results.*** Mental foramen, anterior loop of mental nerve and incisive canal could be observed in 84.2, 66 and 51.7% of the cases. Respectively, lingual foramen was observed in only 6.1% of the radiographs. Gender doesn't affect on the visibility of these structures. There was a relationship between mandibular foramen and canal with age. ***Conclusion.*** Mandibular incisive canal was considered in 51.7% of cases, it was observed that the result obtained was more than those of other researches.

**Key Words:** *mandibular anatomical structures, panoramic radiography, incisive canal, mandible*

## Introduction

Panoramic radiography (also called pantomography) is a radiologic technique for producing a single image of the facial structures that includes both the maxillary and mandibular dental arches and their supporting structures. Since a panoramic radiograph is a two-dimensional (2D) image, visualization of anatomical structures is less precise than cross-sectional imaging (e.g. computerized tomography scanning) [1–4]. This imaging technique is less expensive and that is why it's being used in different fields of dentistry for evaluating jaws relationships and anatomical structures [5].

Several reports have studied the delineation of the mandibular canal and/or the mental foramen [6–12] and incisive canal [13] as visualized on panoramic images. In addition, there are several researches which have studied anatomical variations of the mandibular canal or mandibular foramen [14], anterior looping of mental nerve [15,16] and bifid mandibular canal [17,18]. These anatomical variations show the necessity of radiography before surgical procedures on the mandible in order to estimate the possible dangers during surgery.

Jacobs et al. [19] noted that the mandibular canal and the mental foramen could be observed in the majority of radiographs studied with good visibility. The lingual foramen was visualized with good visibility in 12%. An incisive canal was identified with good visibility in only 1%. An anatomical variation to be considered is the anterior looping of the mental nerve (in 11% of images).

Serman [13] noted that a mandibular incisive canal was present in 0.88% of the cases in a cadaveric study. Also, some researches in Iran have shown that this anatomical structure was identified in 38% of the cases [20].

According to the presence of the anatomical variations in different populations [21] and clinical importance of these structures in dentistry [4,22], we

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evaluated the visualization of these structures in an Iranian population.

The main aim of the present study was to evaluate the visibility of anatomical structures of mandible on panoramic images. This study was done to reach the following objectives:

- Evaluation of the visibility of the anatomical structures of mandible on panoramic radiographs: (1) mandibular canal, (2) mandibular foramen, (3) mental foramen, (4) anterior looping of the mental nerve, (5) incisive canal and (6) lingual foramen;
- To determine the relationship between age or gender and the visibility of these structures; and
- To evaluate the visibility of these structures in different age groups.

## Materials and methods

This study was done at the dental faculty of Shahid Beheshti Medical University in 2009. Images were obtained from Iranian patients without any musculoskeletal disorder who were referred to this faculty.

Panoramic radiographs were obtained by the Planmeca radiography unit (Helsinki, Finland). Standard protocol for panoramic radiography was followed in all the cases. The position of the head was identical for all patients. The Frankfort plane was parallel to the horizontal plane and the central beam was radiated to the mandibles with $-7^{\circ}$ angle relative to the horizontal plane. Exposure parameter settings were as follows: for children kV = 64, mA = 4, time = 15 s; for adult females kV = 64, mA = 5, time = 18 s; for adult males kV = 66, mA = 6, time = 18 s; for obese adult males kV = 66, mA = 7, time = 18 s. Radiographs were obtained from 412 patients (206 males, 206 females) with age range between 7–78 years. All radiographs were taken either for orthodontics treatment or prior to removal of impacted teeth.

Before the radiographic study, a pilot study had been done on five mandibles. These bones belonged to the cadavers of the Department of Anatomy and Biology, Medical Faculty, Shahid Beheshti University, Iran. First of all the mandibles were submerged into ethylene di amine tetra acetic acid (EDTA) for ~ 30 min. After decalcification and consistency softening of the bones, they were dissected in several directions. Then the direction of the infra-alveolar nerve was examined.

The status of any anatomical structure on radiographs was divided into four groups:

(1) present on both sides;
(2) present on right side only;
(3) present on left side only; and
(4) not seen.

Evaluated landmarks are denoted in Figures 1 and 2. For finding the relationship between age and the visualization of the anatomical structures the patients were divided into four age groups:

(1) Childhood and adolescence (first and second decades);
(2) Adulthood (third and fourth decades);
(3) Old adults (fifth and sixth decades); and
(4) Elderly (over 60 years).

Then the visibility of the anatomical structures was evaluated in each group. The reason of such categorization is the maxillofacial development in a specific way in different growth periods and age groups [23,24] and the mineralization changes of jaws because of aging [25–27]. The evaluation of radiographs was done by two general dentists.

### *Statistical analysis*

All calculations were processed using Statistical Package for Social Science statistical software (version 16; SPSS Inc., Chicago, Illinois). Descriptive statistics including tables and graphs were applied for showing information. Phi-Cramer's value was used

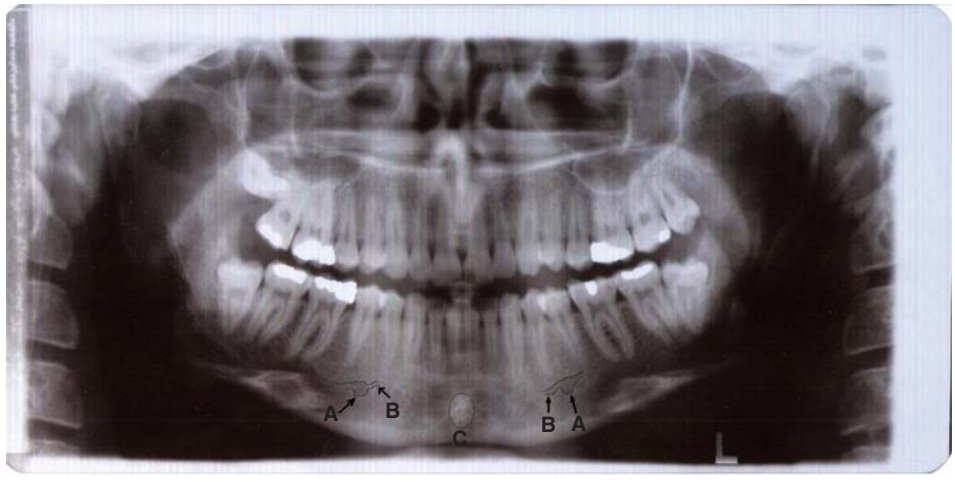


Figure 1. Panoramic view of a 22-year-old man with denoted structures. (A) Mental foramen, (B) incisive canal, (C) lingual foramen.

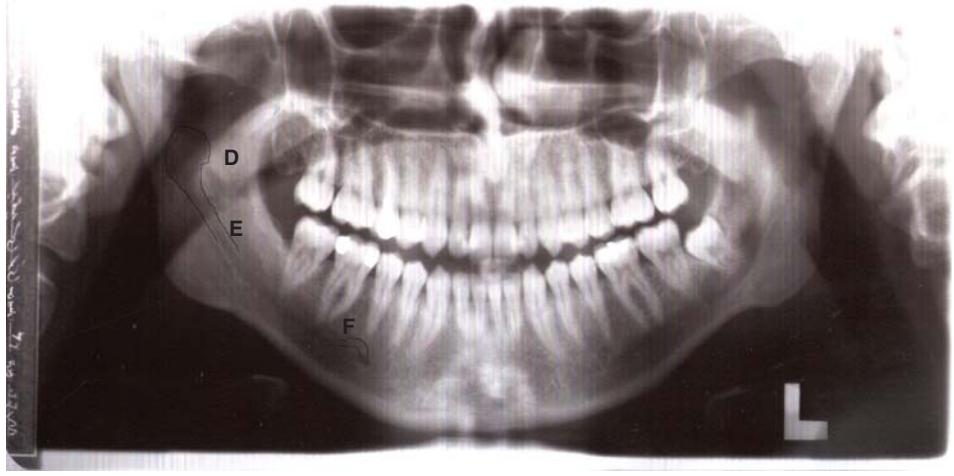


Figure 2. Panoramic view of a 23-year-old man with denoted structures. (D) Mandibular foramen, (E) mandibular canal, (F) anterior looping of the mental nerve.

to determine the influence of gender on the visibility of structures. For comparing the significance categorical findings with respect to age groups Spearman's rho was used. A $p$-value of less than 0.05 was considered statistically significant.

## Results

Only in one case of five dissected mandibles was an incisive canal found (20% of the cases). However, this structure was identified in 51.7% of radiographs ($n$ = 213).

Visualization of the anatomical structures is shown in Table I. The mandibular canal and mandibular foramen have the highest percentage visibility among the structures. They could be observed in more than 99% of the cases. The mandibular canal was assessed in body region of the mandible, since its observation in the ascending ramus is not as important as in the anterior section. After that mental foramen, the anterior loop of mental nerve and mandibular incisive canal could be observed more than the others. Lingual foramen was identified less than other structures. It was visualized in only 6.1% of the cases. This structure was not seen in 93.9% of the radiographs which means that it was not visualized either on the right or left side when it was present. Mental foramen was observed more than other features except for the mandibular foramen and mandibular canal. It was not seen in only ~ 6% of the cases. Incisive canal was absent in only 29.4% of the panoramic radiographs. This finding represents that a lot of mandibular features could be observed by a good technician and appropriate considerations. Anterior loop of mental nerve is an important mandibular feature which needs a lot of consideration in implantology. This structure was visualized in 66% of the cases.

The relationship between gender and appearance of anatomical structures was determined by Phi-Cramer's value. The results of this finding are shown in Figure 3.

Phi-Cramer's value showed that gender has no affect on the appearance of anatomical structures ($p$-value > 0.05).

The age range was between 7–78 years (mean age 38 years). The numbers in each of the different age groups and also gender distribution is shown in Table II. For determining the relationship between age and appearance of anatomical structures the visualization of these structures was evaluated in different age groups. The results are shown in Figure 4.

In all the six landmarks the most visibility belongs to the age group of the third and fourth decades

Table I. Appearance of the anatomical structures on panoramic images.

| | Landmarks | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mandibular foramen | | Mandibular canal | | Mental foramen | | Lingual foramen | | Incisive canal | | Anterior loop | |
| Visualization status | *n* | % | *n* | % | *n* | % | *n* | % | *n* | % | *n* | % |
| Present on both sides | 411 | 99.80 | 410 | 99.50 | 34.7 | 84.20 | 25 | 6.10 | 213 | 51.70 | 272 | 66 |
| Present on the right side | 0 | 0 | 0 | 0 | 19 | 4.30 | 0 | 0 | 36 | 8.70 | 26 | 6.30 |
| Present on the left side | 1 | 0.20 | 2 | 0.50 | 22 | 5.30 | 0 | 0 | 42 | 10.20 | 27 | 6.60 |
| Not seen | 0 | 0 | 0 | 0 | 24 | 5.80 | 287 | 93.90 | 121 | 29.40 | 87 | 21.30 |

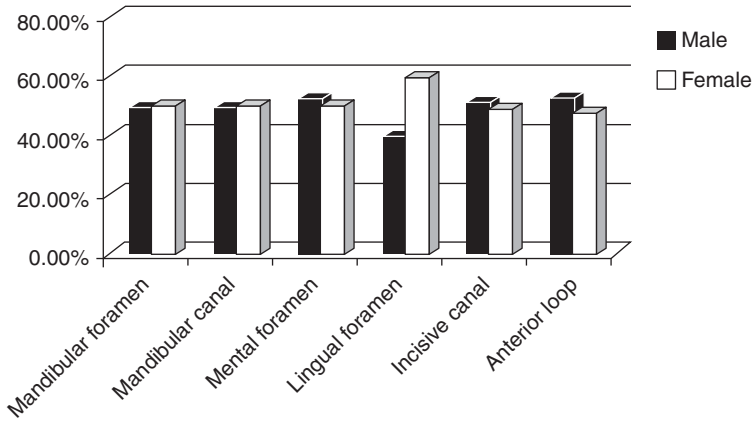


Figure 3. Appearance of anatomical structures in each gender.

(adulthood) and the least—except for the lingual foramen—belongs to the first and second decades (childhood and adolescence). This finding shows that panoramic radiography is suitable for people in the age of 21–40; however, it's not a good technique for children and it does not give enough information to dentists.

For comparing the significance categorical findings with respect to age, Spearman's rho was used. There was a relationship between mandibular foramen ($p$-value = 0.044) and mandibular canal ($p$-value = 0.04) with age. The appearance of these two landmarks increases as the age rises. There was no relationship between other landmarks and age ($p$-value > 0.05).

## Discussion

Mandibular canal and mandibular foramen were observed in more than 99% of the cases. This finding is similar to the findings of other researches [19]. In this study mental foramen could be identified in 84.2% of the cases on both sides of the radiographs and according to the appearance of this landmark on any side of the radiographs it was observed in 94.2% of the cases which is near the findings of other researches [19]. In 20% of the dissected mandibles mandibular incisive canal could be identified which is much more than the finding of Serman's [13] study and less than Jacobs et al. [19] and the radiographic study [19]. The possible reason of this finding could be low number of the cases of cadaveric study, so it's suggested that the cadaveric part of this study be repeated with more cases.

Mandibular incisive canal could be visualized in 51.7% of the cases which is more than findings of other researches [19,20]. Lingual foramen was identified in 6.1% of the cases which is less than other findings [19]. Mandibular incisive canal could be studied all the way down to the incisors in some cases, but it was not visualized throughout in other cases. Actually we should gather that a panoramic view is not a suitable image for evaluating this anatomical structure, although it was observed much more than other studies. Also based on the pilot study we should say that this structure is actually a variation landmark, so the visibility of this structure is various in different populations and races [13,19,21].

Anterior loop of mental nerve was one of the most important evaluated structures of this study. It was visualized in 66% of the radiographs, which was more than other findings of such studies [2]. This landmark is a normal variation of lower jaw, so this finding shows that this variation in an Iranian population is more than other races. The inter-foraminal region of the mandible and the anatomical structures of this region including incisive canal, lingual foramen and anterior loop of mental nerve are important in implantology [2,14,22]. The clinical significance of these findings is that direct damage to the mental nerve or its anterior looping can be avoided if an anterior looping is properly identified during pre-operative radiographic planning. The correct identification of

Table II. Age and gender distribution of examined patients.

| | Age groups | | | | |
|---|---|---|---|---|---|
| Gender | Group I | Group II | Group III | Group IV | Total |
| Male | 10 | 103 | 63 | 30 | 206 |
| Female | 13 | 80 | 70 | 43 | 206 |
| Total | 23 | 183 | 133 | 73 | 412 |

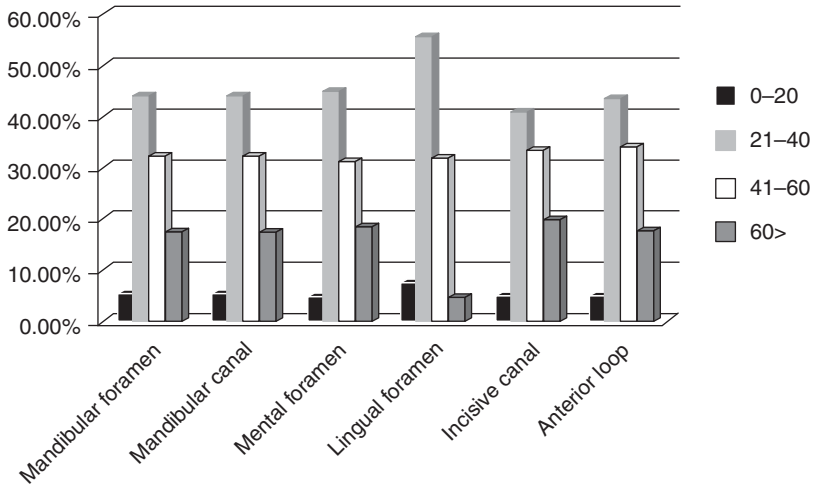


Figure 4. Appearance of anatomical structures in each age group.

the incisive canal and the lingual foramen might be just as important, provided that these structures contain some neurovascular bundle. With considering the importance of this region surgeons should evaluate this area by providing several radiographs (e.g. panoramic radiographs).

In all the six landmarks the most visibility belongs to the age group of the third and fourth decades (adulthood) and the least—except for lingual foramen—belongs to the first and second decades (childhood and adolescence). This finding can be caused by two reasons. First of all the way of development and the mineralization pattern of mandible is various in different age groups. Because of the growth pattern of mental protuberance during the first and second years mental foramen will be displaced from the anterior area of lower jaw to the superioposterior portion of mandible and in adults it is placed between the superior and inferior border of the mandibular body. Because of teeth exfoliation and alveolar degeneration during the ageing, the mandible gets smaller, so mental foramen comes closer to the superior border of mandible. Also condylar cartilage growth causes the elongation of ramus and mandibular growth in anterioinferior direction [23,24]. So the position of mandibular anatomical structures changes during the human growth and skeletal development. According to the direction of the central beam in panoramic radiography the appearance of these structures will be different in each age group.

The second reason that causes different visibility of the structures in various age groups is the changes of bone density during the development. The cortical bone gets thicker and becomes sclerotic during ageing, but collagen amount of the bone will be reduced [25–27]; so radiation absorption and transmission is different in each age group which causes the difference in the appearance of anatomical structures.

According to the above definitions we can say that panoramic radiography is a good imaging technique for people between 20–40 years old, but we should use another imaging technique for children to identify the position of anatomical landmarks.

## Conclusion

Mandibular incisive canal was one of the most important evaluated structures of this study. It was visualized in 51.7% of the radiographs. There should be provided some radiographs base on the requirements of treatment planning before the surgeries. It should be considered that cognizance of the position of anatomical structures during the major maxillofacial surgeries and placement of endosseous implants is too important. So it is necessary to get a desirable radiography technique which provides sufficient information. It is recommended for some research be done on cadavers and CT scans.

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