Visibility of mandibular anatomical landmarks in panoramic radiography: A retrospective study

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Abstract

Aims: To determine the frequency, visibility and gender variations of mental foramen (foramen mentale), incisive canal, anterior loop of mental nerve, and mandibular canal (canal mandibulaire) in different age groups.

Materials and Methods: The study was done in 179 orthopantomograms (OPG) which were taken using Digital Orthophos XG machine. The anatomical landmarks such as mandibular canal, mental foramen, anterior loop of mental nerve, and incisive canal were analyzed in the radiographs and scores were recorded.

Results: According to a sample size of 179, the mandibular canal was visible in 98%. In 16% of the cases, with 14% poor perceptibility anterior looping of the mental nerve was visible. The mental foramen showed good visibility in 51%. In 23% of the cases, the incisive canal was observed. Chi-square test was done which showed the statistical difference with a \( P \) < 0.05 existed between appearance of mandibular canal and age and difference in \( P \) values in males and females in their visibility based on the sample size.

Conclusion: Panoramic radiographs provided sufficient information for mental foramen and mandibular canal. But for better visualization, detection of structures in between for aminal region and for performing surgery for implant placement in this region it may require to be replaced with three-dimensional imaging like cone-beam computed tomography.

Keywords: Anterior loop of mental nerve, cone-beam computed tomography, implants, orthopantomogram

Introduction

Panorography is the frequently used radiographic technique in dentistry.[1] The word panoramic radiography is extracted from panorama which means an unimpeded view of an area in every required direction.[2] It is utilized to estimate the anatomical and structural relationship of mandibular canal, anterior loop of mental nerve, incisive canal, and mental foramen.[3] It can be presumed that there may be large variations in the interforaminal region. It is crucial to locate the mandibular canal and other associated anatomical key structures for implant surgery.

A review of variations in morphology and anatomy related to mandibular canal and other necessary structures are very essential in implant placement as inferior dental nerve bundle exists in varying locations and possesses many differences. Individual, gender, race, age, assessing technique used and the amount of edentulous alveolar ridge resorption largely affects these variations.[4]

Materials and Methods

This study consisted of 179 randomized digital OPG which was stored as soft copies in the extraoral radiographic machine in the Department of Oral Medicine and Maxillofacial Radiology. The radiographs were selected based on the following criteria.

Inclusion criteria

- Images of good quality with respect to contrast
- Devoid of any jaw lesions and traumatic injuries in the mandible
• Images without radiographic exposure or processing artifacts.

**Exclusion criteria**

• Poor quality radiographs
• Presence of processing artifacts
• Presence of jaw fracture in mandible
• Presence of any pathology in the mandible.

The radiographs were randomly selected between the age of 10 and 80 years. All radiographs were taken with a digital machine, SIRONA Orthophos XG 5 Ceph with the following parameters:

• Kilovoltage of 62-73 kVp
• Tube current 8-15 mA
• Time for 15 s.

The mandibular anatomical structures such as mandibular canal, anterior loop of mental nerve, mental foramen, and incisive canal were analyzed. A four-point grading scale was used to note the visibility of these landmarks:^{[5]}

• Good (Above average)
• Moderate (Average)
• Poor (Below average)
• No visibility (not seen).

**Statistical analysis**

Observed data were recorded and analyzed using statistical software. The observations were blinded by single and double observers and calculated using statistics which showed good agreement with both the observers. Chi-square test was done to note the relationship of age and gender with visibility.

**Results**

Out of 179 cases, mandibular canal was visible in 98% [Graph 1 and Table 1] with good perceptability in 34% of the cases [Graph 1 and Figure 1]. In 84% of the cases, anterior loop of the mental nerve was not seen [Graph 1 and Table 1] showing 2% moderate visibility [Figure 1]. In 99% cases [Table 1], foramen mentale was moderately seen [Figure 1]. In 24% of the cases, an incisive canal was observed showing only 1% good visibility [Graph 2 and Figure 2]. Based on sample size and using Chi-square test, gender does not exert effect on the appearance of the anatomical structures in the interforaminal region and also revealed, significant statistical difference existed between visibility and age of mandibular canal and mental foramen with a $P < 0.05$.

**Discussion**

Extraoral radiography like panoramic radiography (also called pantomography) is a technique used for producing a single tomographic image of facial structures, which includes the maxillary and mandibular arches and their supporting structures.^{[1]} However, a OPG is a two-dimensional image,

**Table 1: Males and females - Sample size (179)**

<table>
<thead>
<tr>
<th>Anatomical structures visualized</th>
<th>No visibility (A)</th>
<th>Poor visibility (B)</th>
<th>Moderate visibility (C)</th>
<th>Good visibility (D)</th>
<th>Total visibility (E=B+C+D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular canal</td>
<td>4 (2)</td>
<td>9 (5)</td>
<td>106 (59)</td>
<td>60 (34)</td>
<td>175 (98)</td>
</tr>
<tr>
<td>Anterior looping</td>
<td>150 (84)</td>
<td>25 (14)</td>
<td>4 (2)</td>
<td>0 (0)</td>
<td>29 (16)</td>
</tr>
<tr>
<td>Mental foramen</td>
<td>2 (1)</td>
<td>7 (4)</td>
<td>79 (44)</td>
<td>91 (51)</td>
<td>177 (99)</td>
</tr>
<tr>
<td>Incisive canal</td>
<td>138 (77)</td>
<td>28 (16)</td>
<td>12 (7)</td>
<td>1 (1)</td>
<td>41 (23)</td>
</tr>
</tbody>
</table>

**Figure 1:** Orthopantomogram showing mental foramen, anterior loop of mental nerve, mandibular canal

**Figure 2:** Orthopantomogram showing incisive canal

**Graph 1:** Males and females
The mandibular canal is a canal that takes origin in mandibular foramen on the mesial aspect of the ascending mandibular ramus and slants forward and downward in the ramus, then progresses forwardly in the body until foramen mentale which also carries inferior dental nerve.

The mental foramen is more commonly located at the summit of the second mandibular bicuspid or in between the tips of the bicuspid. Race-related variation is also noted. For instance, it is frequently found at the tip of bicuspid like the second premolar in Chinese subjects. Whereas in Caucasian subjects, it is found between the premolars and by the canine anteriorly or by the first mandibular molar posteriorly. The mental foramen is a significant landmark during osteotomy procedures. The inferior dental nerve may be seen on medial aspect of the mental foramen and passes far away from it as an anterior loop within the bone that should be considered to prevent injury to mental nerve before performing implant surgery.

The mandibular canal embrace the blood vessels and inferior dental nerve which is bifurcated into mental and incisive canals at the roots of premolars. The mental canal diverges near the foramen mentale and appears closer to the alveolar crest after teeth extraction and alveolar bone resorption. In this area, lingual foramen is also located in the midline, which is at the level with or superior to the genial tubercles and has a branch of the incisive artery which anastomosis with the lingual arteries.

The third branch (V3) of the V cranial nerve (trigeminal), i.e. mandibular invades the mandibular foramen, as the inferior dental nerve and progresses anteriorly in the mandibular canal to traverse the lower jaw in linguobuccal direction. The mandibular nerve is half-way between the buccal and lingual cortical bone in the mandibular first molar region where it bifurcates into the mental and incisive nerve.

The mental nerve slants in an upward direction and enters from the foramen mentale combining with vascular vessels in the mental canal. Commonly, three neuronal branches diverges from the mental foramen among them one nerve sensitizes the mucosa of the premolar region, and the others supplies to the mucous membranes, lower lip and the gums as rear as the mandibular second bicuspid. It may provide stimulation to tissues which are next to the mandibular cuspid and lower incisor regions.

Incisive canal in the mandible is a bilateral canal which passes mesially between lingual and vestibular cortices from both foramen mentale’s. It includes nerves and blood vessels which provide innervations to the mandibular incisors, cuspids, and lower first premolar. This area appears to be indistinct and nerve and vascular canals may embrace through a tangle of the intertrabecular meshwork.

In this current article, OPGs were checked for the appearance of anatomical structures in the mandibular region for implant planning. In 98% of the cases, mandibular canal was visible showing 59% moderate visibility. Jacob et al. also noted mandibular canal in 99% of their cases in their study.

In a study by Kamrun et al. noted that the visibility of the superior border was very poorly seen in panoramic images and should be supplemented by three-dimensional computed tomography (CT) images for good visualization. The possible reason could be because as the age advances visibility decreases due to osteoporotic changes in the alveolar bone which reduces the perceptability of mandibular canal.

An anterior loop of mental nerve emerges as the mental canal, which begins from the mandibular canal and passes in outer, upper, and backside directions to summit at the foramen mentale. In a study by Solar et al. categorized into two groups, loop and non-loop types depending on the occurrence of loop. Hun et al. in their cadaver study divided the loops into linear (straight) and upright (vertical). The straight pattern was visible as a mild slope of mental canal entering instantly into the foramen mentale and vertical (upright) pattern was visible when it is curved at right angles into the foramen. Literature showed no further radiographic studies on the above-mentioned pattern.

Direct radiographs have proven that panoramic radiographic studies are unpredictable in locating the loop. Iyengar et al. in a study noticed a visible anterior loop unilaterally in only 21% of the total images viewed and similarly only 10% appeared in the present study.

Different studies have shown that OPGs are considered as unreliable tool in determining the foramen mentale region due to intrinsic drawbacks of imaging plane to record the complete region accurately. Inappropriate postures of persons whom to be exposed also can contribute to the poor visibility.

Mandibular anterior region is considered as a relatively safer zone for implant placement and length of implant may reach up to the lower cortical border of the lower jaw. However, recent reviews signifies probability of occurrence of complications such as subglossal hemorrhage formation, profuse bleeding, and breathing difficulty in this region.

### Conclusion

This study revealed that due to superimposition of various anatomical structures and incorrect patient positioning the visibility of interforamina structures became difficult in the
mental region in panoramic images. So far, the better visibility of this mental region and for identification of foramen anatomy precisely for planning implant surgery it may need to be substituted with other imaging modalities such as CT, cone-beam computed tomography.

Clinical Significance

1. In this study, the predictability of the anatomical landmarks in the lower jaw is well noted which varied with different degree of probability which helps for detection of nerve and sensory problems like anesthesia or paresthesia in the chin and lower lip and also to reduce the accidental issues that have found to happen during implant insertion in the lower bicuspid region.

2. Practical applications:
   - The location of foramen mentale is influenced by age, racial related, amount of tooth loss and degree of bone resorption. The mental foramen is closer to alveolar margin before tooth eruption takes place in children. During the tooth eruption period, mental foramen moves down mid-way between the alveolar margin and the lower border of the lower jaw. It ascend toward the alveolar margin in the adults with intact teeth and alveolar bone resorption. Based on the visibility, the errors during mental nerve block and implant placement, enucleation, osteotomy cuts during orthognathic surgeries, periapical surgeries, mucosal incisions for alveoaloplasties, and vestibuloplasties can be minimized.
   - Depending on the position and visibility of mandibular foramen the common errors with inferior dental nerve block that is insertion of the needle too low on the medial side of the ramus (below the mandibular foramen) and the insertion of the needle too far anteriorly on the medial side of the ramus the errors during blocks can be minimized and also for planning the horizontal osteotomies during bilateral sagittal split osteotomies surgical procedures.
   - The type of the third molar and premolar impactions can also be detected based on anatomical landmarks depending on the visibility in the panoramic radiography.

References
